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Question Paper Code : 40467

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Seventh Semester

Electrical and Electronics Engineering

EE 8009 – CONTROL OF ELECTRICAL DRIVES

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   Compare closed loop and open loop control of DC drive.

2.   Name the advantages of PI controllers.

3.   Write the significance of $\left(\dfrac{V}{f}\right)$ ratio in constant torque region and constant power region.

4.   Define slip power.

5.   What is brushless excitation in synchronous motor drive?

6.   List the demerits of Field Oriented Control (FOC)?

7.   How torque ripple is controlled in SRM drive?

8.   List the drawbacks of BLDC based drive system.

9.   Mention some typical current sensors used in DC drive applications.

10. Why digital platform is preferred for implementing different controllers?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the design of PI controller for current controlled based closed loop control of three phase fully controlled rectifier fed separately excited DC motor implementation with inner current loop. (7)

(ii) Explain the different methods for sensing current. Discuss the advantages and disadvantages of each method. (6)

Or

(b) (i) Derive the overall transfer function $\omega(s)/\omega^*(s)$ for chopper fed separately excited DC motor, implementing speed loop alone with proportional controller. (7)

(ii) Explain how closed loop control of DC drive is implemented using digital processor with a flow chart. (6)

12. (a) (i) Explain the working of induction motor drive with variable voltage and fixed frequency. Also explain the working of induction motor drive with fixed voltage and variable frequency. How the above mentioned two schemes differ from variable voltage and variable frequency operation of induction motor? Justify the above with the help of Torque-Slip characteristics of the same. (7)

(ii) A 3-phase, 415 V, 6 pole, 50 Hz, delta-connected, slip-ring induction motor has rotor resistance of 0.18 Ω and leakage reactance of 0.9 Ω per phase referred to stator. When driving a fan load it runs at full load at 3 % slip. What resistance must be inserted in the rotor circuit to obtain a speed of 880 rpm? Neglect stator impedance and magnetization branch. Stator to rotor turns ratio is 2. (6)

Or

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(b) (i) Explain the principle of vector control with the concept of separately excited DC motor. (7)

(ii) A 415 V, 50 Hz, 6 pole, 980 rpm star connected squirrel-cage induction motor has the following parameters per phase referred to the stator $R_s = 0.21\ \Omega$, $R_r' = 0.09\ \Omega$, $X_s = 0.75\ \Omega$, $X_r' = 0.66\ \Omega$, and $X_m = 21\ \Omega$. The motor is fed by 6-step inverter, which in turn is fed by a 6-pulse fully controlled rectifier.

   (1) If the Rectifier is fed by an AC source of 415 V and 50 Hz, what should the rectifier firing angle be to get the rated fundamental voltage across the motor?

   (2) Calculate the percent increase in copper loss of the machine at 50 Hz compared to the value when fed by a sinusoidal supply. Neglect skin effect.

   (3) If the machine is operated at a constant flux,

   (4) Calculate the inverter frequency at 600 rpm and rated torque.

   (5) Calculate the inverter frequency at 500 rpm and half the rated torque. Also calculate the motor current.

   Neglect the de-rating due to harmonics and use approximate equivalent circuit with referred to stator. (6)

13. (a) (i) Explain the operation of synchronous motor with self control mode and separate control mode. Also highlight the technical difference of the same. (7)

   (ii) What is the need of power factor control using synchronous motor? Also with neat diagram, explain the closed loop control of synchronous motor drive for power factor control. (6)

Or

(b) Explain with the help of block diagram, the working of six sector based Direct Torque Control and also list the different methods used to diminish the Lorque ripple. (13)

14. (a) (i) Show the variation of inductance of coil per phase during the operation of Switched Reluctance machine in motor mode and generator mode with neat waveforms. (7)

   (ii) Explain the operation of instantaneous torque control of SRM using current controllers and flux controllers. (6)

Or

(b) (i) Elucidate the technical difference between sinusoidal and trapezoidal type of brushless DC motor. (7)

   (ii) Describe the control algorithm of current controlled brushless DC motor with necessary block diagram. (6)

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15. (a) Write a technical note on the following (7)

      (i) Phase locked loop

      (ii) Micro-computer control of DC drive (6)

Or

(b) Explain with the help of flow chart, the digital implementation of DC drive in the constant horse power mode of operation. Also highlight the difficulties faced during real time implementation. (13)

PART C — (1 × 15 = 15 marks)

16. (a) Explain how sub synchronous and super synchronous speed is obtained in static Scherbius drive with neat diagram and mathematical expressions. (15)

Or

(b) Draw and explain the experimental set up of closed loop variable frequency PWM inverter fed IM drive with dynamic braking. Also explain the role of each section in the same. (15)

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