

PART C — (1 × 15 = 15 marks)

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Question Paper Code : 50531

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Third Semester

Mechanical Engineering

EE 8353 — ELECTRICAL DRIVES AND CONTROLS

(Common to Manufacturing Engineering/Mechanical and Automation Engineering)

(Regulations 2017)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Sketch the structure of typical electric drive. Write the role of each section.
2. Name the factors to be considered for the selection of power rating for the motors used in the electric drives.
3. Compare electrical braking with mechanical braking.
4. Draw the mechanical characteristics of split-phase and capacitor start single phase induction motor.
5. Name any two protecting devices used in the DC motor starter.
6. Mention, how the rotor resistance affects the torque of three phase induction motor.
7. Specify the applications which demands armature control and field control of DC motor.
8. List the reason for continuous current conduction and discontinuous current conduction in chopper fed DC drives.
9. Mention the technical difference between AC voltage controllers and Inverter in the view of output voltage.
10. What you mean by slip power and write its expression in-terms of slip.

16. (a) A drive has the following parameters: $T = 150 - 0.1N$, Nm, where N is the speed in rpm. Load torque, $T_L = 100$ Nm. Initially the drive is operating in steady state. The characteristics of the load torque are changed to $T_L = 100$ Nm. Calculate initial and final equilibrium speeds. (15)

Or

- (b) A 200V, 875 rpm, 150 A separately excited DC motor has an armature resistance of 0.06Ω it is from a single phase fully controlled rectifier with an AC source voltage of 220 V, 50 Hz. Assuming continuous conduction, calculate (15)
- (i) Firing angle for rated motor torque and 750 rpm.
 - (ii) Firing angle for rated motor torque and (-500) rpm.
 - (iii) Motor speed for $\alpha=160^\circ$ and rated torque.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the various factors influencing the choice of an electric drives. (6)
- (ii) Describe any three classes of duty related to electric drives. (7)

Or

- (b) A motor operates on a periodic duty cycle in which it is clutched to its load for 10 minutes and declutched to run on no-load for 20 minutes. Minimum temperature rise is 40°C. Heating and cooling time constant are equal and have a value of 60 minutes. When load is declutched continuously the temperature rise is 15° C.

Determine,

- (i) Maximum temperature during the duty cycle, and (6)
- (ii) Temperature, when the load is clutched continuously. (7)

In addition, by assuming constant torque load, show the speed variation.

12. (a) Draw the typical speed — torque characteristics of DC shunt motor Also derive the expressions for relationship between speed and torque. Based on the expression, sketch the modified speed — torque characteristics by varying the following factors:

- (i) Supply voltage
- (ii) Armature resistance
- (iii) Field flux

In addition, by assuming constant torque load, show the speed variation.

Or

- (b) (i) Explain the concept of DC dynamic braking and regenerative braking of three phase induction motor. (6)
- (ii) Elucidate any one speed control method for single phase induction motor used for domestic applications. (7)

13. (a) (i) Explain the operation of starter used to limit the starting current of DC series motor with necessary control circuit. (6)
- (ii) Determine a suitable autotransformer ratio for starting a three phase induction motor with a supply current not exceeding twice the full load current. Use the following data: locked rotor current with normal voltage is 5 times the full load current, full load slip is 4%. Also estimate the starting torque in terms of full load torque. Ignore shunt branch current. (7)

Or

- (b) Describe the following starters used for three phase induction motors.

- (i) Stator resistance starter (6)
- (ii) Star – Delta starter (7)

14. (a) (i) Draw and explain the control circuit arrangement of Ward Leonard control system. Also list its advantage and disadvantage. (7)
- (ii) Explain the single phase fully controlled converter fed separately excited DC shunt motor drive. Sketch the waveforms for both continuous current conduction mode and discontinues current conduction mode. (6)

Or

- (b) Explain the four quadrant chopper fed DC drive. Also sketch the voltage, current waveform and equivalent circuit of the drive in each quadrant.

15. (a) (i) Elucidate the conventional speed control methods suitable for the three phase induction motor by varying the following factors: (6)
- (1) Supply voltage
- (2) Supply frequency
- (ii) Explain the voltage / frequency control scheme used for three phase induction motor. Also show the torque variation in-terms of waveform during below the rated voltage and above the rated voltage. (7)

Or

- (b) By using the static Scherbius drive, explain how the slip power is recovered and speed of the induction motor is controlled with necessary illustrations and expressions.