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Question Paper Code : 41001

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Fifth/Sixth/Seventh Semester

Electrical and Electronics Engineering

EE 3012 – ELECTRICAL DRIVES

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. List the major components of an electric drive system.

2. Sketch the equivalent rotational system model of a motor-load system and hence write its fundamental torque equation.

3. Mention the types of time ratio control techniques and list their significance.

4. What are the downsides of the discontinuous conduction mode of operation of power electronic converters?

5. Signify the importance of keeping air gap flux as constant in the variable frequency drives.

6. Why field weakening is needed? List the characteristics of field weakening mode.

7. List the key differences between true control and self-control modes of operation in synchronous motor drives.

8. Mention the types of permanent magnets used in synchronous motors.

9. Why the transfer function approach is a powerful and versatile tool in modeling of electric drive systems?

10. What is the correlation between PI control and hysteresis control in the design of current controllers for electric drives?

PART B — (5 × 13 = 65 marks)

11. (a) Sketch the 4-quadrantal operating modes of an electric drive system. With an example, elucidate the multi-quadrant dynamics of the system under the acceleration, deceleration, starting and stopping modes of operations.

Or

(b) Classify the classes of duty cycle of an electric drive. Hence, explain the methodology for selecting the motor based on the drive duty cycle.

12. (a) Sketch and explain the block diagram representation of the current limit control of an electric drive system. Hence, classify the types of current limit control techniques and list their limitations.

Or

(b) A 230 V, 960 rpm and 200 A separately excited dc motor has an armature resistance of 0.02 Ω. The motor is fed from a chopper which provides both motoring and braking operations. The source has a voltage of 230 V. Assuming continuous conduction

(i) Calculate duty ratio of chopper for motoring operation at rated torque and 350 rpm (5)

(ii) Calculate duty ratio of chopper for braking operation at rated torque and 350 rpm (5)

(iii) If maximum duty ratio of chopper is limited to 0.95 and maximum permissible motor current is twice the rated, calculate maximum permissible motor speed obtainable without field weakening and power fed to the source. (3)

13. (a) With power and control schematic, explain the v/f control of a 3-Ø induction motor drive system. Sketch the speed vs torque characteristics of such a system and infer its response under dynamic conditions.

Or

(b) Classify the types of basic loop structures required for closed-loop control of electric drive. Sketch its block diagram representation for an electric drive system and hence explain the same.

14. (a) Using block diagram, explain the concept of self-controlled synchronous motor drive using constant margin angle control.

Or

(b) With schematics, explain the construction, working principle, and torque generation of a permanent magnet synchronous motor.

15. (a) With the transfer function approach, discuss the methodology involved in the design of speed controller of a separately excited DC motor drive.

Or

(b) What factors are crucial for selection of converter for closed loop control of an electric drive? Elucidate the same and bring out the required characteristics of the converter for its optimal performance.

PART C — (1 × 15 = 15 marks)

16. (a) With power schematics and waveforms, explain the operation of 1-Ø fully controlled converter-fed separately excited DC motor drive system by sketching its operating quadrantal modes, average output voltage vs firing angle, and the speed vs torque characteristics. Hence, infer the response of such a system under the CCM and DCM modes of operations.

Or

(b) Sketch the equivalent circuit for the armature and field of a separately excited DC motor drive. Hence, derive its transfer function and infer its response a step change in load torque under dynamic loaded conditions.

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