18EE741

USN

Seventh Semester B.E. Degree Examination, Dec.2023/Jan.2024
Industrial Drives and Applications

Time: 3 hrs.   Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1   a. What are electrical drives? Draw a block diagram of an electrical drive and explain the parts of an electrical drive. **(07 Marks)**

    b. A motor drive has a load which has rotational motion, coupled through a reduction gear with $a = 0.1$ and efficiency of 85%. The load has a moment of inertia of 10kg-m^2 and a torque of 10N-m. Motor has an inertia of 0.2kg-m^2 and runs at a constant speed of 1420rpm. Determine equivalent inertia referred to the motor shaft and power developed by the motor. **(06 Marks)**

    c. Explain with a block diagram, the closed-loop converter fed dc motor drives. **(07 Marks)**

OR

2   a. Explain the factors on which the choice of an electrical drive depends on. **(07 Marks)**

    b. A motor equipped with a flywheel is to supply a load torque of 2000N-m for 8 sec followed by a light load period of 180N-m long enough for flywheel to regain its steady-state speed. It is desired to limit the motor torque to 800N-m. Motor has an inertia of 10kg-m^2. Its no load speed is 500rpm and slip at a torque of 500N-m is 5%. Assuming, speed-torque characteristics of motor to be a straight line, calculate the moment of inertia of the fly wheel. **(07 Marks)**

    c. Explain modes of operation of an electrical drive. **(06 Marks)**

Module-2

3   a. With circuit diagram and necessary waveforms, explain single phase fully controlled rectifier control of dc separately excited motor. Derive the expression of average voltage. **(10 Marks)**

    b. A separately excited dc motor is fed from a 230V, 50Hz supply through a single phase, half controlled bridge rectifier. Armatures resistance and inductance are respectively 0.3Ω and 0.06H. The motor voltage constant is $K_a = 0.9$V/A rad/s and field resistance is $R_f = 104$Ω. The field current is set to maximum possible value. The load torque is $T_L = 50$N-m at 800rpm. Assuming armature and field current are continuous and ripple free, compute the field current and firing angle of the converter in armature circuit. **(10 Marks)**

OR

4   a. Explain first quadrant operation of a class A chopper connected to a dc separately excited motor. **(07 Marks)**

    b. Explain chopper control of dc series motor. **(07 Marks)**

    c. A separately excited dc motor with an armature resistance of 0.01Ω works on a dc supply of 220V, it draws an armature current of 100A and rated speed is 1000rpm. It is fed from a chopper controller. Assuming continuous conduction, calculate duty ratio at rated torque with speed of 500rpm during motoring. **(06 Marks)**

Module-3

5 a. Explain stator voltage control of Induction motors. Draw typical speed-torque curves for variation in stator voltage. **(06 Marks)**

b. For a 3-ϕ star connected 4 pole, 50Hz, 415V, 1460rpm squirell cage induction motor has $R_1 = 0.65\Omega$, $R_2 = 0.35\Omega$, $X_1 = 0.95\Omega$, $X_m = 28\Omega$, $X_2 = 1.43\Omega$. The motor is operated by varying stator voltage and frequency keeping V/F ratio constant at the rated condition. Determine the maximum torque and speed at which it occurs for stator frequencies of
i) 50Hz, ii) 35Hz. **(09 Marks)**

c. Explain single phasing of induction motors. **(05 Marks)**

OR

6 a. Explain Variable Voltage Frequency (V/F) control of induction motors. **(06 Marks)**

b. A 440V, 3ϕ, 50Hz, 6 pole, 945rpm delta connected induction motor has following parameters referred to stator side. $R_1 = 2\Omega$, $R_2 = 2\Omega$, $X_1 = 3\Omega$, $X_2 = 4\Omega$. Motor speed is controlled by stator voltage control to run motor at 800rpm. Calculate:
i) Torque developed by the motor
ii) Voltage to be applied to motor
iii) The current drawn. **(09 Marks)**

c. Explain operation of three phase induction motor with unbalanced motor impedances. **(05 Marks)**

Module-4

7 a. Explain with necessary diagrams the control of induction motors by current source inverter. **(08 Marks)**

b. For a 3-phase, delta connected 6-pole 50Hz, 400V, 925rpm squirell cage induction motor, $R_s = 0.2\Omega$, $X_s = 0.5\Omega$, $X_r = 1.1\Omega$. The motor is operated from voltage source inverter with constant V/F ratio from 0 to 50Hz and having constant voltage of 400V above 50Hz frequency. Calculate:
i) Speed for a frequency of 35Hz with half full load torque.
ii) Torque for a frequency of 35Hz for a speed of 650rpm. **(06 Marks)**

c. Explain with a diagram, the variable frequency control of synchronous motors (multiple motors). **(06 Marks)**

OR

8 a. Explain with diagrams, cycloconverter control of three phase induction motors. **(08 Marks)**

b. Explain speed-torque characteristics of a synchronous motor with a fixed frequency supply. **(06 Marks)**

c. Explain speed control of single phase induction motors. **(06 Marks)**

Module-5

9 a. Explain self controlled synchronous motor drive employing load commutated thyristor inverter. **(10 Marks)**

b. Explain industrial drives used in
i) Textile mills
ii) Steel rolling mills. **(10 Marks)**

OR

10 a. Explain torque versus stepping rate characteristics of a stepper motor. **(06 Marks)**

b. Write short notes on Brushless DC motor drives. **(08 Marks)**

c. Explain industrial drives used for cranes and hoists. **(06 Marks)**

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