

KATHMANDU UNIVERSITY  
EndSemester Examination  
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Level : B.E.  
Year : IV  
Time : 2 hrs. 30 mins.

Course : EPEG 422  
Semester: I  
F.M. : 40

SECTION "B"

[5 Q × 8 = 40 marks]

Attempt ANY FIVE questions. Assume any suitable data if required.

1. a. Express the performance equation of a dc series motor and plot its characteristic curve showing variation of torque, power, armature current, flux and terminal voltage against speed. [2]
  - b. The speed of a separately excited dc motor is controlled by a single phase full wave converter. The field circuit is controlled by a full converter and field current is set to maximum value. The ac supply voltage to the armature and field converter is single phase 440V, 50 Hz. The armature resistance is  $0.25\Omega$  and field resistance is  $175\Omega$  and the motor voltage constant is  $K_V = 1.4 \text{ V/A-rad/sec}$ . the armature current corresponding to the load demand is  $I_a = 45\text{A}$ . If the delay angle of the armature converter is  $\alpha_a = 60^\circ$  and armature current is 45A. Determine, [1+1=2]
    - i. Torque developed by the motor,  $T_d$ .
    - ii. Back e.m.f,  $E_b$ .
    - iii. Speed,  $\omega$  in r.p.m.
  - c. A dc series motor is powered by dc chopper from 600V dc source. The armature resistance  $R_a$  and field resistances are  $0.02\Omega$  and  $0.03\Omega$  respectively. Back e.m.f constant of the motor is  $K_V = 15.27 \text{ mV/A-rad/sec}$ . the average armature current is,  $I_a = 250 \text{ A}$ . Armature current is continuous and ripple free. If the duty cycle of the chopper is 60%, determine [1+1+1+1=4]
    - i. Input power from the source,  $P_{in}$ .
    - ii. Equivalent input resistance of the chopper drive,  $R_{eq}$ .
    - iii. Motor speed,  $\omega$  in rpm.
    - iv. Developed torque,  $T_d$ .
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2. a. The speed of a 100 hp, 600 V, 1800 rpm, separately excited dc motor is controlled by a 3 phase full converter, the converter is operated from three phase, 480V, 60 Hz supply, and the rated armature current of motor is 165A. The motor parameters are  $R_a = 0.0874 \text{ ohm}$ ,  $L_a = 6.5 \text{ mH}$  and  $K_a\phi = 0.33 \text{ V/rpm}$ . The converter and ac supply are considered to be ideal. Calculate, [2+2+1=5]
    - i. No load speed at firing angle  $30^\circ$ , assuming that at no load, armature current is 10% of rated current and is continuous.
    - ii. What will be firing angle to obtain rated speed of 1800 rpm at rated motor current.
    - iii. Obtain the speed regulation.
  - b. An inverter is used in the speed control circuit of a 6 pole induction motor with rating of 230V, 50 Hz. Determine the approximate speed required for the inverters for speed of  
i) 900 rpm, ii) 1200 rpm and iii) 1400 rpm. [3]

3. a. Explain the volt/hertz method of speed control of a three phase induction motor and obtain the speed torque characteristic of three phase induction motor with volt/hertz method of speed control. [5]
- b. A three phase 420 V, 4 pole 50 Hz, star connected slip ring induction motor has its speed controlled by GTO chopper in its rotor circuit. The effective per phase turns ratio from rotor to stator is 0.8. The per phase stator and rotor resistances are 0.015 ohm and 0.02 ohm respectively. Load torque is proportional to speed squared at 450 Nm at 1440 rpm and the value of chopper resistance for a minimum value of speed is 2.0134 Ohm. If the speed is increased to 1320 rpm, calculate, [1+1+1=3]
- Duty cycle of chopper circuit.
  - Rectified output voltage.
  - Efficiency
4. a. Describe about the closed loop control of an induction motor with static Kramer drive. [3]
- b. A 3 phase 400 V, 50 Hz, 6 pole star connected round rotor synchronous motor has  $Z_s = 0+j2$  ohm. Load torque, proportional to speed squared is 340 Nm at rated synchronous speed. The speed of the motor is lowered by keeping V/f constant and maintaining unity power factor by field control of motor. For the motor operation at 600 rpm. Neglecting rotational losses, calculate [1+1+1+1+1=5]
- Supply voltage.
  - Armature current.
  - Excitation voltage.
  - Load angle and
  - Pull out torque.
5. a. Describe about the Static VAR Compensation configuration employed in power system for the purpose of power factor improvement. [3]
- b. A three phase 11.2 kW, 1750 rpm, 460 V, 60 Hz four pole Y connected induction motor has the following parameters:  $R_s=0.66$  ohm,  $R_r^1 = 0.38$  ohm,  $X_s = 1.14$  ohm,  $X_r^1 = 1.71$  ohm and  $X_m=33.2$  ohm. The no load loss is negligible. The motor is controlled by a current source inverter and the input current is maintained constant at 20A. If the frequency is 40 Hz and the developed torque is 55 Nm. Determine. [1+1+1+1+1=5]
- Slip for maximum torque and maximum torque.
  - The slip.
  - The rotor speed.
  - Terminal voltage per phase.
  - The power factor.
6. a. Obtain Ward Leonard system of speed control characteristic for a separately excited dc motor type of characteristic from a three phase induction motor. [4]
- b. Describe static Kramer drive for the speed control of a 3-phase SRIM and show that the steady state torque is not influenced by whether a transformer is used or not. [4]