EEL305 Electric Drives
Major test

Max Marks: 50
Date and Time: 30th November 2006 10:30 am - 12:30 pm
Venue: II-325

I.Short Questions: (8 x 2=16 MARKS)

A. The suburban traction systems were normally using single-phase DC series motor drives although their capacity is more than 50 kW. Why?
B. A multi stack variable reluctance stepper motor with 4 stacks and 9 rotor teeth will have a step angle of --- degrees. If a pulse of 1 kHz frequency excites the stacks of the machine sequentially, then the speed would be -------- rpm.
C. A PM DC motor with brushes is commonly used for applications below its rated speed only - State True or False and justify.
D. Which of the following braking schemes can be effectively used for both slip-ring as well as squirrel cage 3-phase induction motors? (a) Capacitor braking (b) DC dynamic braking (c) Plugging (d) Zero sequence braking. Draw the speed-Torque curves for those schemes only.
E. Arrange the following braking techniques in decreasing order of energy efficiency: Plugging, Regenerative braking, dynamic braking.
F. If a 3-phase synchronous motor with Permanent Magnet in its rotor is to be used in self-controlled mode, how can you achieve field weakening while it is operating above rated speed? Justify with the help of a phasor diagram.
G. Draw the family of speed-torque curves of a separately excited DC motor drive working under (a) Dynamic braking with varying external resistance (b) armature voltage control (c) field current control (d) Reverse current braking with varying armature resistances.
H. Give one application each for the following motors: (i) Switched reluctance motor (ii)Universal Motor (iii)Capacitor run Single phase induction motor (iv)Hybrid stepper motor

2. Draw the schematic diagram of slip-energy recovery scheme for the speed control of a 3-phase wound rotor induction motor. Draw its phasor diagram indicating input voltage, supply side current, I_{stator}, I_{rotor}, $I_{inverter}$ and power factor angle in the supply side. (5 MARKS)

3. A drive has the following parameters:J=50 kgm^2. Electromagnetic Torque in N-m =100 - 0.1N and T_L=0.1N where N is the speed in rpm. Initially the drive is operating in steady state. Now it is to be reversed with the motor characteristics changing to Te= -100 - 0.1N. Calculate the time taken for reversal. (4 MARKS)

4. (a) Derive the expression to calculate the moment of inertia of a flywheel which can equalize the load on an electric motor by releasing its stored kinetic energy at the time of excessive load demand.

(b) A motor is equipped with a flywheel to supply a load torque of 500 Nm for 12 sec followed by a no-load period long enough for the flywheel to regain its full speed. If the maximum torque that can be delivered by the motor is 400 Nm, what should be the moment of inertia of the flywheel? The no-load speed of the motor is 600 rpm and it runs at 552 rpm while delivering 300 Nm torque. The moment of inertia of the motor is 10 kg m^2. What should be the rating of this motor? (6 MARKS)

5. The speed of a 3-phase Y connected permanent magnet synchronous motor rated at 15 kW, 440 V 60Hz 1800 rpm (rated PF=0.8 lag) is controlled in True synchronous mode with V/f being constant until rated speed and V being fixed at rated value above rated speed. Xs=13 Ω. Ra=0. (a) If the machine is operating at rated armature current, calculate the torque, power output, Terminal voltage and power factor for 50% of rated speed. (b) If the machine should supply 80% of rated power for all speeds above base speed, what will be the maximum available speed for such an application? (6 MARKS)

6. A DC motor is driven from a chopper with a source voltage of 24 V DC and at a frequency of 1 kHz. Determine the variation required in the duty cycle to deliver a constant torque of 2 pu when the speed has to be varied from 0 to 1 pu. The motor details are 1 hp, 10V, 2500 rpm, 78.5% efficiency, Ra = 0.01Ω La=2 mH Back emf constant =0.03819 V.Sec/rad. The on-state drop aeross the device in the one-quadrant chopper is 1 V. (4 MARKS)

7. A 440V,50Hz, 970 rpm, 6 pole, Y conneeted 3-phase wound rotor induction motor has Rs=0.1 Ω R2'= 0.08 Ω X1=0.3 Ω X2'=0.4 Ω. The stator to rotor turns ratio is 2. Motor is started by inserting resistances in rotor circuit and later the speed is controlled by slip-energy recovery (SER) scheme. Drive is designed to operate from 100% to 80% synchronous speed. Maximum value of firing angle of the inverter is 165°. Calculate (a) the resistance to be inserted in the rotor circuit to obtain maximum torque at starting (b) Transformer turns ratio at the inverter side for obtaining specified speed control range in SER (c) Torque for a speed of 800 rpm and α=140°(d) Firing angle for half the rated torque and a speed of 850 rpm.. Neglect the resistance of the DC link inductor. (6 MARKS)

8 A Switched reluctance motor drive has a Lmin=10 mH and Lmax=150 mH. It has a rated current of 10 Amp and rated speed of 1500 rpm. The number of stator poles and rotor poles are 8 and 6 respectively. If it is operated as a stepper motor what is the step angle? If it has to be rotated at rated speed what is the frequency of pulses to be given to each phase of the stepper motor? Assuming a linear variation of induetance calculate the rated torque of the SRM. (3 MARKS)