EEL745 Electrical Drives System
Major Test

Date and Time: 2/5/2008 8-10 am
Venue: II-337
Max Marks: 40

1. Short questions: **(9x 2 =18 marks)**
   a. If a switched reluctance motor is analysed with and without taking into account the effect of magnetic saturation, in which of these two eases the electromagnetic torque developed will be more? Justify your answer.
   b. A 3-phase induction motor operating from a constant frequency constant voltage supply cannot be operated in the so-called "unstable" region of its speed-torque characteristies- Is this statement TRUE for all types of loads? Justify.
   c. A salient pole synchronous motor is running on rated load from an infinite bus. Suddenly the DC exeitation to the field is cut off. Will the machine work normally at this condition too? Explain.
   d. Can a 3-phase AC voltage controller be used for providing soft-start to a 3-phase PMSM? Justify your answer.
   e. The full-load speed of a 3-phase induction motor (8 pole, 50Hz) is 730 rpm. $R_2'$ per phase is 0.2Ω. Calculate the external resistance to be included in the rotor circuit to lower the speed to 620 rpm considering that the torque remains the same.
   f. A 220 V DC shunt motor has $R_a$=0.2Ω and $I_{no\text{-}load}$ = 2.5 A when running at 1400 rpm. Determine its speed while taking 60 A current from the mains, if armature weakens the field flux by 3%
   g. Give one typical application for the following motors / drives: (i) Universal motor (ii) 2-phase induction motor (iii) static Scherbius drive (iv) Switched reluctance motor
   h. An AC voltage eontroller used for energy saving at light loads will be more effective in a single phase induction motor as compared to a 3-phase induction motor. –State TRUE or FALSE and justify.
   i. For a 3-phase induction motor drive operating below base speed, the breakdown torque is always higher when fed with a CSI than the case when the same motor is fed with a VSI - State TRUE or FALSE and justify.

2. A 15 kW 400V 30A 950 rpm 50Hz 3-ph Y conneeted eage induction motor takes 6 times its rated current and develops 1.8 times rated torque while starting direct-on-line. If rated torque is to be developed at starting (i) what voltage must be applied during starting? (iii) what would be the current drawn by the motor at this voltage? (ii) If a variac is used for obtaining this voltage, what will be the line current drawn from the supply? (iv) If the starting current is to be limited to rated current, then what will be the starting torque value? **(4 marks)**
3. A synchronous motor drive fed by an LCI has the following name-plate details: 10 MW, 3-phase, 11 kV, Y connected, 60 Hz, 6 pole, UPF. The parameters are Xs=12Ω and sub-transient reactance = 3Ω; Rs is negligible. The filed is controlled to maintain constant flux below base speed and armature voltage is frozen at rated value above base speed. The drive operates at a eonstant commutation lead angle of 60°. (a) calculate the margin angle (γ), torque, terminal voltage, when the motor is operating at 1200 rpm drawing rated armature current. (b) If the current is restricted to rated value and a minimum margin angle of 10° is to be maintained for successful commutation, ealculate the maximum speed at which the motor can operate. **(6.5 marks)**
4. A 3 hp, 135 V, 1500 rpm separately excited DC motor is controlled by a buck chopper whose frequeney and input voltage are 500 Hz and 180 V respectively. Ra=0.8 Ω La=3 mH. Back emf constant=0.763 V.sec/rad. The motor is to bc run at rated torque at 300 rpm with a maximum torque pulsation of 2%. Is this chopper suitable for this application? Justify your answer by proper calculations. If not, suggest a suitable frequency of operation for the chopper. **(4 marks)**
5. (a) An electric motor has a full-load Cu loss = 1.25 times constant losses. Its final steady state temperature rise is 48°C. $\tau_h$=75 minutes. Find the half-hour rating of the machine. Derive any formulae that is used. **(4 marks)**
   (b) A motor driving a colliery winding equipment has to deliver a load having the following eharacteristics: (i) Rising uniformly from zero to a maximum of 2000 kW in 20 sec during the acceleration period. (ii) 1000 kW for 40 sec during full-speed period. (iii) during deceleration period of 10 sec, whwn regenerative braking is taking place, the power retuned to the supply falls from an initial value of 330 kW to zero. (iv) the next load cycle starts after a rest time of 20 sec. What should be the power rating of the motor chosen for this application? **(3.5 marks)**

3φ full converter with source inductance $\left\{ \frac{3V_m}{\pi}\left[\cos\alpha - \cos(\alpha+\mu)\right] = \text{DC link voltage} = \frac{3V_m}{\pi}\cos\alpha - \frac{3\omega L_s I_d}{\pi} \right.$