DEPARTMENT OF ELECTRICAL ENGINEERING
M. Tech. POWER ELECRONICS, ELECRTICAL MACHINES AND DRIVES (PEEMD)
EEL841: Solid State Controllers of Drives
Major Test

TIME – TWO HOURS **MAXIMUM MARKS-300**

Q.1. (a) Draw circuits of type A, B, C, D, E and multiphase choppers to feed dc motor drives. [6]
(b) Draw circuits of the three-phase (i) semi-controlled half-wave, (ii) semi-controlled full-wave, (iii) fully controlled half-wave, (iv) fully controlled full-wave, (v) dual controlled full-wave, (vi) semi-controlled bridge, (vii) fully controlled bridge, (viii) dual bridge phase controlled ac-dc converters to feed dc motors drives. [16]
(c) Draw circuits of (i) 6-pulse thyristor bridge rectifier-GTO based CSI, (ii) 12-pulse thyristor bridge rectifier-IGBT based PWM CSI, (iii) 18-pulse thyristor bridge rectifier-GTO based PWM CSI, (iv) 12-pulse thyristor bridge rectifier-12-pulse LCI, (v) GTO based PWM current source converter feeding GTO based CSI, (vi) 12-pulse GTO based current source converter feeding GTO based PWM CSI for feeding synchronous motor drives. [12]
(b) Draw circuits of (i) 6-pulse diode bridge rectifier-two level voltage source inverter (VSI), (ii) 12-pulse diode bridge rectifier-three level VSI, (iii) 18-pulse diode bridge rectifier-two level VSI, (iv) 24-pulse diode bridge rectifier-three level VSI, (v) two level voltage source converter feeding two level voltage source inverter (VSI), (vi) three level voltage source converter feeding three level VSI, (vii) 12-pulse voltage source converter feeding two level VSI, (viii) 24-pulse voltage source converter feeding two level VSI for feeding synchronous motor drives. [16]
(d) Draw five converters circuits for the control of switched reluctance motors. [10]

Q.2. A three-phase fully controlled bridge converter is operated as LCI to feed a battery power of 15 kW from a 400 V dc to ac synchronous motor of 3-phase, 415V (L-L) rms, 50Hz. A large inductor is included in series with battery, which has a resistant of 1.0 ohm. Calculate dc link current, power loss in the dc link resistor, thyristor rms current, power factor, and firing angle of thyristors. [20]

Q.3. A 3-phase, 4-pole, 3000 rpm permanent magnet brushless dc motor driving a pump (having load torque profile for maximum power tracking of PV array) is fed from a PV array with a open circuit voltage of 120 V and short circuit current level of 30A through a 3-phase square wave VSI connected to stator winding of the motor. Per phase winding resistance is 0.5 ohms/phase. It has peak open circuit back emf per phase of 50 V at rated speed. For starting, calculate (a) peak current of the winding, rms current of the winding, developed torque of the motor, (b) speed, winding current, torque, PV array current and power at maximum power condition if a PV array characteristic is approximated to straight line. [40]

Q.4. In a battery-driven truck, the battery voltage is 240 V. It employs a dc motor with armature resistance of 0.50 ohms through step down dc chopper. During motoring, when truck is moving up hill at some speed its back-emf is 180 V and the motor current is 20A. Calculate (i) the duty ratio, (ii) value of peak, rms, and average current in the battery, and (iii) values of peak, rms, and average current of the solid-state switch and diode. [40]

Q.5. A three-phase, 1.93 kW, 3325 rpm, 4-pole, star connected permanent magnet synchronous motor has the following parameters: L_d=9.1 mH, L_q= 11.5 mH, J=0.0015 kgm^2, Flux linkage=0.191 Tesla and R_s=1Ω. It is controlled in vector controlled mode with single-phase power factor corrected (PFC) ac-dc converter having an input supply of 220V, 50 Hz at almost unity power factor feeding VSI at 400V dc bus voltage. The motor is controlled with constant flux below base speed and constant rated voltage above base speed. Calculate supply rms current, supply power, average dc bus current, reference d-q components of stator current, rms stator current at starting if starting torque is required the rated torque. [50]

Q.6. A 3-phase, 22 kW, 415V (line), 50Hz, Y-connected, 4-pole squirrel cage induction motor has the following parameters: R_s = 0.18 Ω, R_r =0.24 Ω, X_{lr}= X_{ls}= 0.5 Ω, X_m= 12 Ω, J = 0.1384 kg-m^2. Its full load pf is 0.88 and efficiency is 0.90. Its full load speed is 1460 rpm. The motor is controlled with constant flux below base speed and constant rated voltage above base speed. The speed of the motor is controlled using indirect vector control scheme through a three-phase PWM VSC fed PWM VSI with an almost unity power factor at ac mains of 415V, 50 Hz and dc bus voltage of 650V. Calculate the supply rms current, supply active power, average dc link current, reference d-q components of stator current, rms stator current at 50% of rated speed and at rated torque. Neglect core and friction and windage losses. [50]

Q.7. A 4-phase, 4kW, 1500 rpm switched reluctance motor (SRM) with 8-stator and 6-rotor poles has a stator pole arc of 30° and rotor pole arc of 22.5°. The aligned inductance is 110 mH and the unaligned inductance is 11 mH. The resistance per phase is 1Ω. Saturation can be neglected. An eight device converter is fed from a battery of 120V used to supply 4-phase stator winding of the motor. The motor is used in an industry as pallet truck. Calculate (a) average battery current, peak and rms winding current to obtain the instantaneous torque eight times the rated torque at starting when two phases are excited simultaneously, (b) average battery current, and peak and rms winding current at the rated torque at 50% of the rated speed when only one phase is excited. [40]

*****BEST OF LUCK*****