EEL209 Power Electronics
Major Test

Date and Time: 3/5/2009 8-10 am
Venue: II-325
Max Marks: 50

1. Short Questions: **(6 x 3 = 18 marks)**

a) HVDC transmission happens to be less expensive for shorter distances (< 500 km) than AC transmission. State TRUE or FALSE and justify your answer.

b) Which one of the following two will have a better efficiency – A Switched mode power supply (SMPS) using a normal DC-DC converter, An SMPS using a resonant converter. Give reason(s) for your choice.

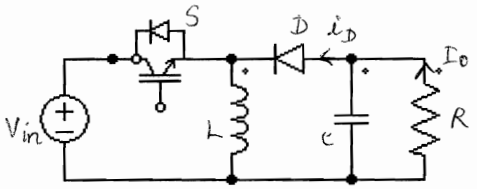
c) A solar powered car is supposed to be driven by a 2 hp, 200V 3-phase induction motor. Each solar cell has a voltage of 2.5 V. Which one of the following power electronic circuits will be best suited for controlling the motor from the array of solar cells: (i) a 3-phase VSI with SVM control (ii) a VSI with Sinusoidal PWM control (iii) 3-phase multi-level voltage source inverter . Give reason(s) for your choice.

d) Which of the following two devices is more suitable for a high power (100's of kW) application and why? (i) IGBT (ii) IGCT

e) Draw a representation circuit diagram for a matrix converter and mention its one advantage and one disadvantage.

f) On-line UPS is more expensive and complex in terms its construction and control than the off-line UPS - Is this statement TRUE? Justify your answer.

2. A buck-boost converter circuit is shown below:




(a) Derive the expressions for input, output voltage relationship, critical value of inductance for maintaining continuous current and output voltage ripple. (b) Draw the waveforms of $i_C$, Vc, Io, $i_{diode}$, and voltage across the diode and the switch. (c) Design a buck-boost converter with Vo=12V, Po=24W, Vin = 24V, fs=50 kHz, output voltage ripple should be within 2%. What will be the value of maximum inductor current? **(8 marks)**

3. A three-phase fully controlled bridge converter is used to charge a battery at a power of 10kW, 280V dc from an ac of 3-phase, 400V(L-L) rms, 50 Hz. A large inductor is included in series with battery, which has a resistance of 1.0 ohm. Calculate dc link current, power loss in the dc link resistor, peak value of thyristor current, power factor, firing angle of thyristors. If the same converter is operated as a line commutated inverter by inverting the battery terminals, what is the firing angle at which the converter should operate for a DC link current of 10 A? For the inverter mode of operation draw the waveforms of (i) AC side voltage (ii) DC link voltage (battery + voltage across inductor) (iii) Voltage across device 1 (in A phase upper portion) (iv) current in the DC link (v) current on the AC side in A phase. If a source inductance of 0.1 mH is considered, how will it affect the output voltage magnitude while the converter was working as a rectifier for charging the battery? **((8 marks) (Expressions:** $\frac{3V_m}{\pi}\cos\alpha = V_{dc}$ ; where $V_m$ = Line to Line peak ) Commutation overlap drop $= \frac{3\omega L_s I_d}{\pi}$

4. A 3-phase AC voltage controller is feeding a delta connected R-L load with the firing angle being 60° and the power factor angle of the load being 45°. The source is star connected with negligible source inductance. Draw the waveform of phase current, phase voltage, Voltage across device no.1 and line current for this operating condition. Assuming the conduction ends at angle β for device no. 1, derive the output voltage expression (per phase) in terms of the input voltages, delay angle α and β. If the source inductance effect is included, then what will be the change in these waveforms. ( **7 marks**)

5. (a) A 1.2 MW 3-phase induction motor is being employed in an electric traction system that travels through mountainous terrain. The train is powered by 1500 V DC and it needs to be converted into AC before being fed to the motor. Which one will suit this application – a CSI or a VSI? Justify your answer. **(3 marks)**

(b) Consider a single-phase full-bridge voltage source inverter working with selective harmonic elimination technique. The harmonics to be eliminated are 3rd, 5th, 7th and 9th.The fundamental component has to have about 60% of $V_{dc}$ as its rms value. How many switchings per quarter cycle will be needed for satisfying these conditions? Write the equations corresponding to this involving the switching angles. How does selective harmonic elimination compare with sinusoidal PWM technique in terms of performance and ease of implementation? **(6 marks)**