KIMATHI UNIVERSITY COLLEGE OF TECHNOLOGY

THIRD YEAR FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2308: POWER ELECTRONICS I

DATE: AUGUST 2011 **TIME: 2 HOURS**

INSTRUCTIONS;
Answer ANY THREE questions.
All questions carry EQUAL marks [20 Marks].

QUESTION ONE

(a)

(i) Define power electronics.

(ii) Name and describe four types of power processing.

(iii) State the advantages of power semiconductor devices over the traditional types of power electronic devices. **[10 Marks]**

(b)

(i) Identify the constructional features that distinguish power diode from a level signal diode.

(ii) Explain the difference between the I-V characteristics of a power diode and a level signal diode.

(iii) For the circuit of Fig Q1(b), the switch is closed at t=0 s and when its opened, a freewheeling current If=20 A flows through the load RL, load inductance LL and freewheeling diode DF. The diode reverse recovery current is 20 A and it then decays to zero at the rate of 10 A/μs. the load is rated at 10 Ω and the forward on state voltage drop is neglected.

- Draw the current waveform during the reverse recovery and find its time.
- Calculate the maximum voltage across the diode during the reverse recovery process. **[10 Marks]**

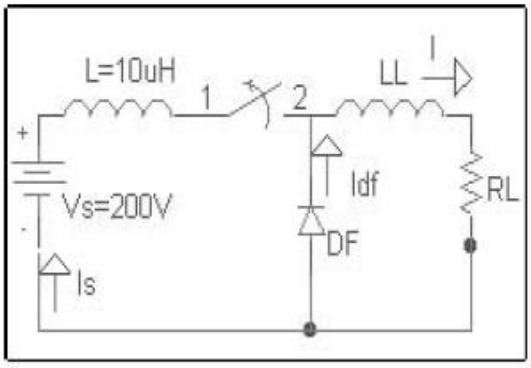

Fig. Q1(b)

QUESTION TWO

(a) Explain the following methods of thyristor triggering

(i) Forward voltage triggering

(ii) Gate triggering

(iii) Dv/dt triggering**.** **[6 Marks]**

(b) A highly inductive load is to be supplied from a single phase full wave diode rectifier. The load requires 12 A at 150 V. the ac supply is from the 240 V mains. Produce the design details of the centre-tap and bridge rectifier circuits and compare the two designs(calculate the PIV of diodes, the transformer kVA, the transformer ratio, the transformer primary current, the mean and rms values of diode currents and diode losses for both configuration) Assume that the diode drop is fixed at 0.7 V. **[14 Marks]**

QUESTION THREE

(a) Explain the need of commutation in thyristor circuits. What are the different methods of commutation schemes? Discuss one of them that involve two thyristors, with a neat schematic and waveforms. **[8 Mark]**

(b) A single phase controlled bridge rectifier has an input supply voltage of 120 V at 50 Hz. The load resistance is 5 Ω and the load inductance is 0.02 H(connected in series). If the firing angle of the thyristors is kept at 60^{o}.

i) Draw the circuit schema

ii) Draw load voltage and current waveforms

iii) Calculate the mean and rms values of load voltage

iv) Calculate the mean load current value

v) Draw the voltage waveform between the inductor terminals.

[12 Marks]

QUESTION FOUR

(a)

(i) Discuss the conditions which must be satisfied for turn on of a thyristor with a gate signal.

(ii) The thyristor of Fig. Q4(a) has a latching current of 30 mA. Neglecting forward voltage drop across the thyristor from the instant of commencement of the gate pulse, determine the minimum duration of the gate pulse necessary to ensure turn ON.

[6 Marks]

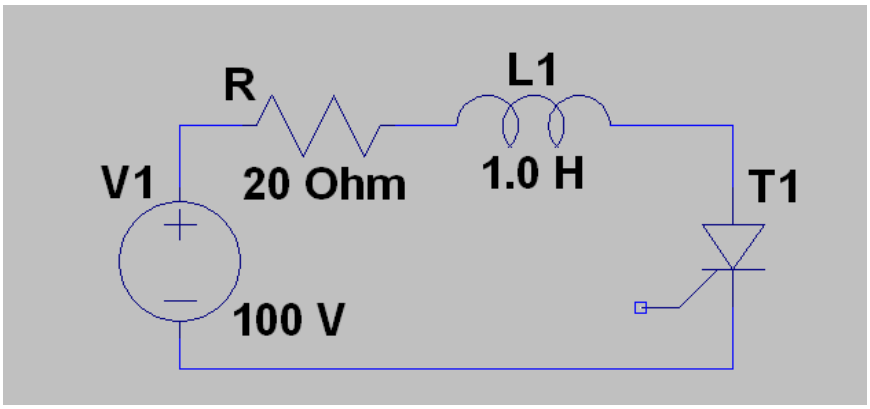

Fig. Q4(a)

(b) A diode connects a dc source in series with *LC* network. The capacitor is initially charged to voltage V_o with upper plate positive. Draw the circuit schematic.

(i) If the diode is turned on at t=0, derive expressions for current through and voltage across *C*.

(ii) Sketch waveforms for output current, capacitor voltage and diode voltage.

(iii) Find the conduction time of diode, peak current through the diode and final steady state voltage across C in case V_s=400 V, V_o=100 V, L=100 µH and C=30 µF. determine also the voltage across diode after it stops conduction.

[14 Marks]

QUESTION FIVE

(a) For a dc battery charger circuit with supply voltage V_m=230V, 50Hz and load resistance R_L=8Ω and back emf E=150V:

(i) Sketch the circuit schema and explain its mode of operation

(ii) Derive expressions for load current $i_o(t)$ and calculate the average current

(iii) Calculate the power supplied to battery and that dissipated in the resistor.

(iv) Draw waveforms for load current and diode voltage. **[12 Marks]**

(b)

(i) What are the main constructional differences between a Power MOSFET and a power BJT? What effect do they have on the current conduction mechanism of a MOSFET?

(ii) How do you expect the gate source capacitance of a power MOSFET to vary with the gate source voltage? Explain. **[8 Marks]**

END.