

**KIMATHI UNIVERSITY COLLEGE OF TECHNOLOGY  
THIRD YEAR SPECIAL/SUPPLEMENTARY EXAM**

**BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRICAL  
ENGINEERING**

**EEE 2308: POWER ELECTRONICS I**

**DATE: MARCH 2012**

**TIME: 2 HOURS**

**INSTRUCTIONS:**

*Answer ANY THREE questions.*

*All questions carry EQUAL marks [20 Marks].*

**QUESTION ONE**

- (a)
- (i) What is power processing? Sketch a block diagram of power processing and explain the role played by each of the main elements. **[5 Marks]**
  - (ii) Explain how efficiency is an essential factor to consider when undertaking design of power electronics devices. **[2 Marks]**
- (b) A single phase, **controlled** bridge rectifier is supplying a resistive load of  $20\Omega$  from a 220V, 50Hz AC source. The firing angle of thyristors is  $60^\circ$ .
- (i) Draw the circuit arrangement and waveforms for load output current and voltage.
  - (ii) Calculate the mean value of the load voltage and load current.
  - (iii) Calculate the form factor (FF) and ripple factor (RF) of the circuit.
  - (iv) Calculate the input power factor. **[13 Marks]**

## **QUESTION TWO**

- (a)
- (i) Discuss the advantages and disadvantages of power conversion using power electronic devices. **[4 Marks]**
- (ii) What is thyristor commutation? Discuss the following types of thyristor commutation:
- Forced commutation
  - Load commutation. **[5 Marks]**
- (b) A single phase half wave diode rectifier is to supply power to a  $1000\ \Omega$  load from a  $230\ \text{V}$  ac supply. The diode has an internal resistance of  $20\ \Omega$ . Draw the circuit schema and the waveform of input supply voltage, load current and diode voltage and then calculate:
- (i) The peak load current
- (ii) The dc average load current
- (iii) The dc diode voltage
- (iv) The % regulation from no load to the given load. **[11 Marks]**

## **QUESTION THREE**

- (a)
- i) Explain the principle of operation of an SCR using two transistor model.
- ii) What is the need for thyristor protection? Explain how thyristors are protected against high  $di/dt$  and high  $dv/dt$ .
- iii) Sketch the static V-I characteristics of an SCR and explain:
- Latching current
  - Holding current
  - Break over voltage
  - Non repetitive peak reverse voltage
  - Turn off time.

**[12 Mark]**

- (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 bridge rectifier circuit( i.e 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.) **[8 Marks]**

#### **QUESTION FOUR**

- (a)
- (i) With aid of a neat schematic and waveforms discuss how voltage thyristor commutation can be achieved.
  - (ii) A current thyristor commutated circuit has a capacitance  $C=30\ \mu\text{F}$  and inductance  $L=4\ \mu\text{H}$ . the initial capacitor voltage is  $V_o=200\text{V}$ . Determine the circuit turn off time for the load current  $I_o=250\text{A}$ . **[10 Marks]**
- (b)
- (i) With aid of necessary circuits and waveforms discuss the switching (turn on and turn off) characteristics of a power diode.
  - (ii) A capacitor initially charged to a voltage  $V_o$  with upper plate positive is connected in series to a switch SW, a power diode D and a resistor R. if the switch is closed at time  $t=0$ :
    - derive expression for the current in the circuit and voltage across the capacitor
    - What is the peak value of diode current and also the energy dissipated in the circuit.
    - Sketch circuit current and capacitor voltage waveforms **[10 Marks]**

### **QUESTION FIVE**

- (a) For a dc battery charger circuit with supply voltage  $V_m=230V$ ,  $50Hz$  and load resistance  $R_L=8\Omega$  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.**