TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology in Conjunction with Kenya Institute of Highways and Building & Technology (KIHBT)

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

HIGHER DIPLOMA IN TECHNOLOGY

EEP 3105: POWER ELECTRONICS I

END OF SEMESTER EXAMINATION
SERIES: MAY 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*
- *Drawing Instruments*
- *Non-Programmable Calculator*

This paper consists of **FIVE** questions. Answer any **THREE** questions
All questions carry equal marks
Use neat, large and well labeled diagrams where required
This paper consists of **THREE** printed pages

Question One

a) With the aid of the static characteristics of a thyristor define the following terms:
   (i) Latching current
   (ii) Holding current
   (iii) Reverse break over voltage **(6 marks)**

b) The supply to a three-phase half-wave diode rectifier has a source impedance of 0.08p.a calculate the required voltage of the transfer secondary to feed a load of 60v, 50A. Assume a diode voltage drop of 0.7V **(6 marks)**

c) An ideal chopper operating at a frequency of 500Hz supplies a load of 3ΩA having an inductance of 10mH from a 60V battery. Assuming that the load is shunted by a perfect communicating diode, and the battery to be lossless. Calculate the load current for ON/OFF ratios of:
   (i) 1/1
   (ii) 4/1
   (iii) ¼ **(8 marks)**

Question Two

a) (i) Draw the transistor equivalent circuit of a TRIAC and explain its operation.

   (ii) With the aid of a circuit diagram and waveforms explain how a TRIAC can be used to control the average a.c power to a load **(10 marks)**

b) (i) Describe the word "overlap" as used in three phase rectifier circuits.

   (ii) Explain why a three phase rectifier circuit does not trip during the overlap period.

   (iii) Derive the expression of overlap angle in three phase controlled rectifier **(10 marks)**

Question Three

a) (i) Using the two transistor analogy of the thyristor, determine an expression for the forward current of the derive and state the condition for the Thyristor to switch from the blocking to conducting states. **(8 marks)**

   (ii) Explain the following firing techniques in thyristor circuits:
      I. Burst firing
      II. Phase control **(4 marks)**

b) (i) Draw the basic circuit diagram and waveforms for a phase controlled inverse parallel a.c controller.

   (ii) If the controller in 3(b) (i) above is used to supply a swimming pool heaters whose elements are 20Ω and supplied from $240V_{r.m.s}$. Calculate the power developed if the delay angle is $\pi/2$ **(8 marks)**

Question Four

a) (i) Derive the mean voltage expression for the circuit of figure 1 **(5 marks)**

Figure 1

(ii) The brightness of a 100W, 240V lamp is varied by controlled the firing angle of figure 1 circuit appearing across each SCR is 240V, calculate:

I. $V_{r.m.s}$ in the lamp at a firing angle of 60^o

II. $I_{r.m.s}$ in the lamp at a firing angle of 30^o **(8 marks)**

b) (i) With the aid of a diagram show how simultaneous firing of two thyristors used in fully controlled circuit is achieved.

(ii) Show that the output voltage for a single phase half wave thyristor controlled rectifier is:

$$V_{mean} = 0.159V_m(1+\cos\alpha)$$

(8 marks)

Question Five

a) (i) With the aid of a circuit diagram and waveforms, explain the principle of operation of a cycloconverter

(ii) A separately excited d.c motor with $R_a = 0.3\Omega$ and $L_a = 5mH$ is to be speed controlled over a range 0 – 2000 r.p.m. The d.c supply is 220V. The load torque is constant and requires and average armature current of 25A calculate:-

The range of duty-cycle required if the motor design constant $K_a\phi = 0.0016$

(4 marks)

b) Draw the UJT relaxation oscillator and derive the expression of its charging resistor R

(6 marks)