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 3107: POWER ELECTRONICS II

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) Explain the importance of freewheeling diode in rectifier circuits **(2 marks)**

b) A half-controlled single phase bridge circuit with a commutating diode is supplied at 120V, 50Hz. If the load is highly inductive and taking a current of 10A
   (i) Draw the voltage and current output waveforms in the circuit at a fining delay angle of 90^o
   (ii) Determine the value of the overlap angle given that the supply inductance is 3mH and the firing angle is maintained at 90^o **(7 marks)**

c) (i) Separately illustrate the following in three-phase controlled rectification:
   I. Overlap angle
   II. Inversion mode of Thyristor operation

   (ii) With the aid of sketches of three phase rectification derive the expression of the circulating current during overlap period. **(11 marks)**

Question Two

a) With the aid of a block diagram explain the operation of a variable speed drive for d.c motors **(5 marks)**

b) (i) Draw the circuit diagram of a single phase cycloconverter using a centre-tapped transformer and draw its waveforms.

   (ii) A cycloconverter designed for industrial application start conducting from $\left(\frac{-\pi}{p}+\alpha\right)$ to $\left(\frac{+\pi}{p}+\alpha\right)$. Derive its expression for the mean voltage **(10 marks)**

c) A three phase cycloconverter supplies a single phase load of 250V, 50A at 0.8 lagging power factor. Calculator the mean voltage and current if the load of the cycloconverter is 100Ω and the firing angle $\alpha = 30^o$ **(5 marks)**

Question Three

a) Sketch the relationship of the characteristic impedance and the frequency of the following networks:
   (i) $\pi - Filter$
   (ii) T – filter **(4 marks)**

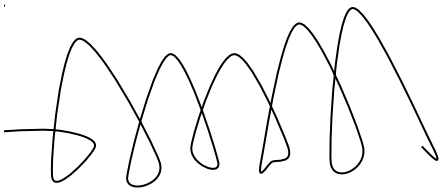
b) (i) For the T-section of figure 1 define the characteristics impedance Z_{oT} of the section and hence . show that:

$$CoshP = 1 + \frac{Z_1}{ZZ_2}$$

OUTPUT

(ii) Deduce the relationship between the impendence of a symmetrical $\pi -$ network and that of an equivalent T-network **(10 marks)**

c) For the circuit of figure 2 determine from first principles the iterative impedance of the equivalent T-network for a frequency of 1kHz **(6 marks)**



Question Four

a) (i) Explain the operation of figures below **(5 marks)**

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(ii) Draw the output waveforms of the circuit in 4(a) (i) **(3 marks)**

b) Draw the circuit of a Mc Murray Bedford invertor and describe its operation **(5 marks)**

c) (i) Explain the principle of operation of a step-down DC chopper by use of the basic circuit

(ii) A step-up dc chopper has VIN = $220V_{d.c}$ and Vo = $660V_{d.c}$. If the non-conducting time of the thyristor switch is 80µs, calculate the pulse width of the output voltage **(7 marks)**

Question Five

a) (i) Explain the THREE main techniques used in programming industrial robots.

(ii) With the aid of a block diagram describe the operation of a Direct Numerical Control (DNC) system **(11 marks)**

b) (i) Describe how a CNC part program can be created and any TWO methods used to store data in numerical machines.

(ii) Explain the FOUR basic elements of industrial robots **(9 marks)**