KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2010/2011

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

SCE 426: POWER ELECTRONICS

DATE: Tuesday 23rd November, 2010 **TIME:** 8.00 a.m. – 10.00 a.m.

INSTRUCTIONS

Attempt Question ONE and any other TWO questions.

QUESTION ONE.

a) i) Explain the principle of operation of a thyristor. (3 Marks)

ii) Describe the mechanisms by a thyristor can be triggered into conduction. (6 Marks)

b) A three – phase star connected sinusoidal voltage supply has a peak value E_M per phase. This supplies power to a load resistor R through a three – phase, half wave bridge circuit shown in Fig. Q I (b). The three diodes may be considered as ideal switches.

i) Sketch the phase current waveforms *ia (wt)* in phase a with respect to the phase voltage *van (wt) = Em sin wt.* (3 Marks)

ii) Calculate the *r.m.s* value *Iav* of the phase current compared with the value for sinusoidal operation. (3 Marks)

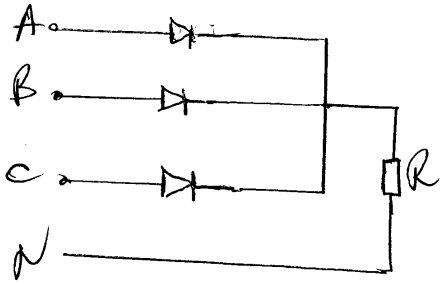

Fig Q 1(b)

c) With the aid of a three phase circuit diagram of an inverter, explain the principles of operation and deduce the expression for the phase and line voltages respectively.(6Marks

d) i) Explain the principles of basic DC chopper (3 Marks

ii) A DC buck chopper operates at a frequency of 1KHz from a 100v V_{DC} source supplying a 10Ω resistance load. The inductive component of the load is 50mH. If the average output voltage is 50V, find;

i) Duty cycle

ii) RMS value of the load voltage

iii) Peak to peak supple current. (6 Marks)

e) Using Fourier series determine the expression for the magnitude and phase angle of the fundamental component of the voltage for six – thyristor inverter when two thyristors conduct simultaneously. (3 Marks)

QUESTION TWO

a) Derive an expression for the R.M.S load voltage in a single – phase resistive circuit where load voltage is varied by firing angle adjustment of a pair of thyristors connected in inverse parallel. (8 Marks)

b) An ideal single – phase supply of fixed voltage and frequency denoted by e = Em Sin wt supplies power to a pusely resistive load with power through an arrangement of four diodes and an ideal thyristor as shown in fig Q 2.

i) Sketch the supply current waveform and the load current wave form for a thyristor firing angle of 60^0. (6 Marks)

ii) Derive an expression for the r. m. s value of supply current in terms of E. and α. (6 Marks)

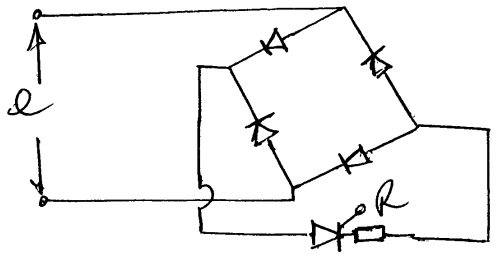

fig Q 2

QUESTION THREE.

a) Explain the two basic methods for controlling the load power from an *A.C* power supply. (8 Marks)

b) The wave forms of the current in a single phase thyristor circuit with resistive load is shown in Fig. Q 3(b). The corresponding supply voltage is given by $e = EmSinwt$.

i) Calculate the average value of the current

ii) Explain what is the lowest order of harmonic associated with the wave form.

iii) What value of per unit power would be transferred to a resistive load by a current of this wave shape?

iv) Calculate the value of the corresponding power factor. (12 Marks)

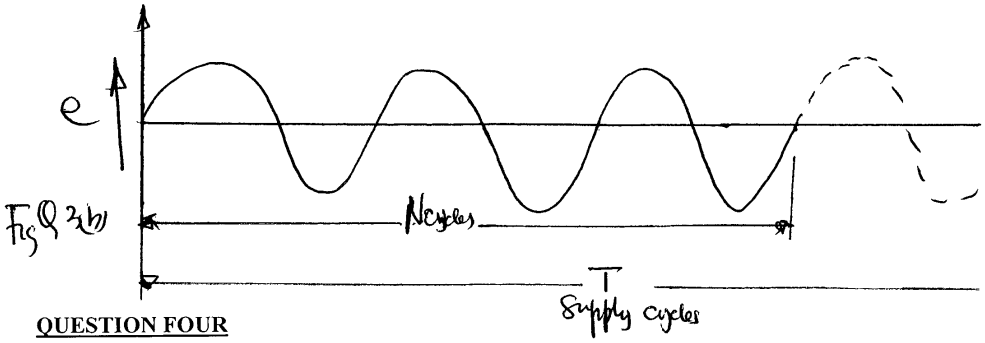

Fig Q 3(b)

QUESTION FOUR

a) i) Sketch the skeleton circuit of the basic force commutated six thyristor inverter with direct supply voltage 2V. Explain the switching mode in which three thyristors conduct simultaneously at all times and specify the conduction pattern by reference to numbers on the circuit rectifies. (6 Marks)

ii) Deduce and sketch the phase voltage V_{AN}, V_{BN} and V_{eN} and line voltage V_{AB} wave form on open circuit indicating which rectifiers are conducting in each 60^0 period of a complete cycle. Determine the phase difference between the fundamental line voltage V_{AB} and the fundamental phase voltage V_{AN1}. (8 Marks)

b) In the three phase bridge inverter, the DC supply voltage is 600v. Determine the r.m.s value of the load line – line voltage and load phase voltage. (6 Marks)

QUESTION FIVE.

a) Explain the principle of operation of a Morgan chopper. (6 Marks)

b) Fig Q. 5b shows a two – quadrant chopper which is used to control the speed of the DC motor and also for regenerative breaking of the motor. The motor constant is $k\Phi = 0.1V/rpm(Ea = k\Phi_n)$. The chopping frequency is $f_c = 250H_2$ and the motor armature resistance is $Ra = 0.2\Omega$. the inductance La is sufficiently large and the motor current *ia* can be assumed to be ripple free. The supply voltage is 120V.

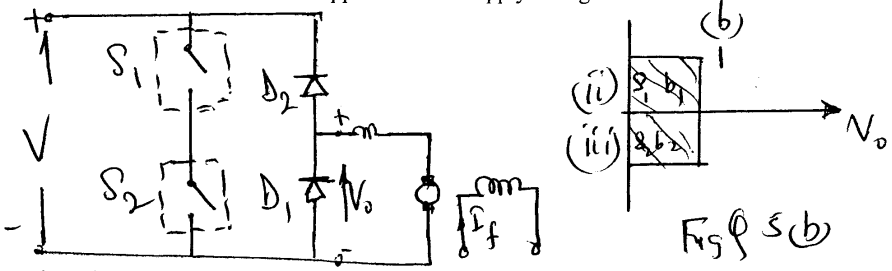

Fig Q 5(b)

Chopper S_1 and diode D_1 are operated to control the speed of the motor. At $n = 400\ rpm$ and $i_0 = 100A$

i) Draw the waveform of V_0, i_o and i_s.

ii) Determine the turn – on time (t_{on}) of the chopper.

iii) Determine the power developed by the motor power absorbed by R_a and power from the source. (14 Marks)