ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FIRST SEMESTER EXAMINATION 2017/2018 ACADEMIC SESSION

COURSE TITLE: POWER ELECTRONICS

COURSE CODE: EEE 533

EXAMINATION DATE: 23RD MARCH 2018

COURSE LECTURER: DR P.K. OLULOPE

HOD'S SIGNATURE

TIME ALLOWED: 2 HOURS

INSTRUCTIONS:

1. ANSWER FOUR QUESTIONS ONLY

2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.

3. YOU ARE NOT ALLOWED TO BORROW ANY WRITING MATERIALS DURING THE EXAMINATION.

QUESTION ONE (25 MARKS)

a. List five commonly available power switches and state the characteristics of these switches according to the following categories
   i. Turn off
   ii. Turn on
   State the rating, forward voltage drop and switching time of the power switches (5 Marks)

b. Differentiate between MOSFETs and IGBTs (2 Marks)

c. Write short notes on the four power converters (8 Marks)

d. In a simple amplifier circuit (Fig. 1) with base resistance, RB = 50 K, RE = 2 K, RC = 3K, VCC = 10 V, hfe = 100, determine whether or not the silicon transistor is in the saturation and find I_B and I_C. (10 Marks)

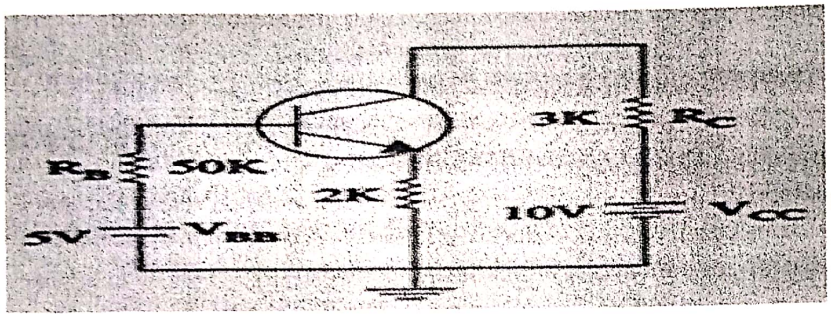

Fig1

QUESTION TWO (25 MARKS)

a. Explain the followings stating the load voltage equations, the current equations, average load voltage, root-means square load voltage and any other necessary equations.
   i. Single phase half-wave controlled rectifier
   ii. Single phase full-wave controlled rectifier
   iii. Full wave half-controlled bridge with inductive load (3 marks each)

b. Draw appropriate waveform diagrams the behaviour of the circuit diagram of the followings
   i. Full wave half-controlled bridge with resistive load
   ii. Full wave half-controlled bridge with inductive load
   iii. Full wave full-controlled bridge with inductive load (3 marks each)

c. A separately excited d.c motor is driven from a 240V, 50Hz supply using a fully controlled thyristor bridge. The motor has an armature resistance R_a of 1.0 ohm and an armature voltage constant k_v of 0.8 V/rad.s . The field current is constant at its rated value. Assume that the armature current is steady. Determine the values of armature current and torque for an armature speed of 1600 rev/min and a firing angle delay of (a) 30^0 (b) 60^0 (7 marks)

QUESTION THREE (25 MARKS)

a. Explain with appropriate diagram and analytical equation the VI characteristic of a low power junction diode. (5 Marks)

b. State four main applications of a semiconductor diode (2 Marks)

c. A certain P-N junction diode has a leakage current of 10−14 A at room temperature of 27°C and 10−9 A at 125°C. The diode is forward-biased with a constant-current source of 1 mA at room temperature. If current is assumed to remain constant, calculate the junction barrier voltage at room temperature and at 125°C. (7 Marks)

d. Explain briefly the followings with appropriate wave form and equations
   i. Full wave full-controlled bridge with separately excited D.C motor
   ii. Full wave half-controlled bridge with separately excited D.C motor (3Marks each)

e. A d.c. to d.c. chopper has an inductive load of 1 Ω resistance and 10mH inductance. Source voltage is 24 V. The frequency of the chopper is set to 100Hz and the on-time to 5 ms. Determine the average load currents. (5 marks)

QUESTION FOUR (25 MARKS)

a. Sketch the circuit diagram of a Mosfet d.c. to d.c. chopper supplying variable voltage to a resistive load. With the aid of a voltage waveform diagram, obtain an expression for the average load voltage. (7 Marks)

b. Draw a circuit diagram of a d.c. series motor chopper drive, and by means of voltage and current waveforms show the behaviour of the circuit. (8 marks)

c. The three phase half wave controlled converter is replaced by a three phase fully controlled thyristor converter. Load and supply remain unchanged i.e highly inductive load of 10 ohm and a three phase supply of 240V at 50Hz. Determine the values of average load voltage and current, rms phase current, load power and converter power factor for a firing angle delay of (a) $\alpha = 30^0$ (b) $\alpha = 75^0$ (c) What are the maximum values of load power and converter power factor obtainable from the circuit? (10 marks)

QUESTION FIVE (25 MARKS)

a. Explain what you means by junction break down (2 Marks)

b. Explain the two mechanisms responsible for breakdown under increasing reverse voltage (4 Marks)

c. A silicon diode has a forward voltage drop of 1.2 V for a forward dc current of 100 mA. It has a reverse current of 1 μA for a reverse voltage of 10 V. Calculate (a) bulk and reverse resistance of the diode (b) ac resistance at forward dc current of (i) 2.5 mA and (ii) 25 mA (10 Marks)

d. Find the current through the 20 Ω resistor shown in Fig. 5. Each silicon diode has a barrier potential of 0.7 V and a dynamic resistance of 2 Ω. Use the diode equivalent (9 Marks)

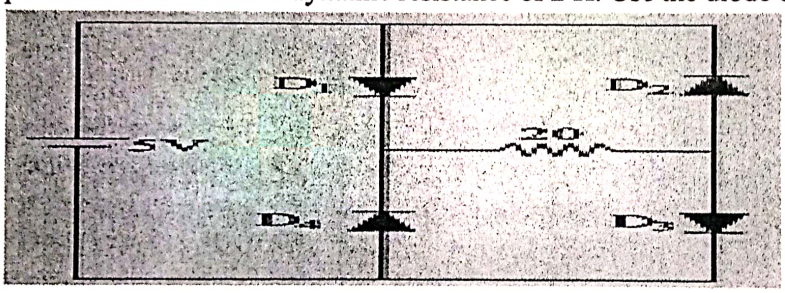

Fig 5

QUESTION SIX (25 MARKS)

a. Explain the following with appropriate equations
   i. Diffusion or Storage Capacitance (CD)
   ii. Transition Capacitance (CT) or Space-charge Capacitance
   iii. Characteristic of common base transistor (3 Marks each)

b. Explain how a quasi-sine wave can be produced in an inverter (2 Marks)

c. A three-phase Mosfet inverter is connected between a balanced star-connected resistive load with $R_L = 10\ \Omega$ and a 250V d.c. supply. The inverter frequency is set at 33 Hz, and the switches have 120^0 conduction periods. Sketch and scale one of the line current waveforms, and calculate the load power. (7 Marks)

d. Sketch the circuit diagram and the output current waveform of a half-bridge inverter with capacitive bridge elements and a resistive load. State the equations for maximum and minimum load voltages, assuming ideal switches and a symmetrical waveform. (7 Marks)