UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE
DEPARTMENT OF ELECTRONIC ENGINEERING

MAIN EXAMINATION 2006

TITLE OF PAPER : INTRODUCTION TO ANALOG & DIGITAL ELECTRONICS

COURSE NUMBER : E212

TIME ALLOWED : THREE (3) HOURS

INSTRUCTIONS : ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS

EACH QUESTION CARRIES 25 MARKS

MARKS FOR DIFFERENT SECTIONS ARE SHOWN IN THE RIGHT-HAND MARGIN

THIS PAPER HAS SIX (6) PAGES, INCLUDING THIS PAGE

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

Question 1

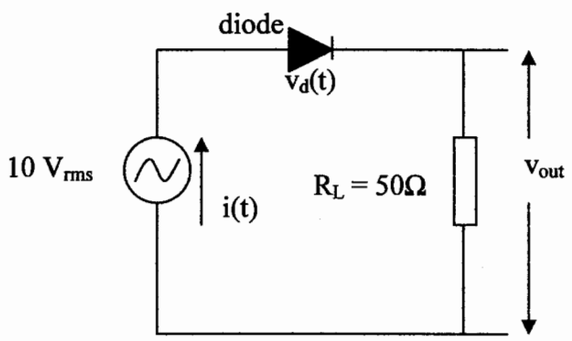
(a)(i) With the aid of suitable diagrams, describe the structure of a p-n junction silicon diode as well as the forward and reverse biasing of the diode.

(12 marks)

(ii) Calculate the forward current of a diode for a voltage of 0.5V. Assume saturation current of 0.01μA and a temperature of 300K. Electron charge is 1.6×10^{-19}C. The Boltzman's constant is 1.38×10^{-23}J/K

(2 marks)

(b) Consider the following half-wave rectifier circuit diagram



Assuming ideal conditions,

(i) Briefly explain its operation (4 marks)

(ii) Sketch a graph showing fully labelled waveforms of the instantaneous supply voltage and the instantaneous diode current, showing clearly their peak values over one cycle. Assume the power supply frequency is 50 Hz. (5 marks)

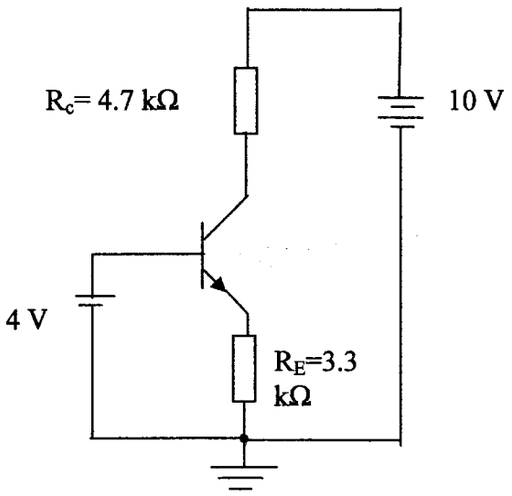
(iii) Calculate the **dc value** of the output voltage (2 marks)

Question 2

(a) (i) Given that $\alpha = I_C/I_E$ and $\beta = I_C/I_B$, show that

$\beta = \alpha /(1-\alpha)$ (5 marks)

(ii) Given the following circuit and assuming β=100 and $V_{BE} = 0.7$, determine all node voltages and branch currents (V_E, I_E, I_C, V_C, and I_B) (10 marks)



(iii) Find β given that a silicon transistor has $I_C = 9.9$mA and $I_E = 10$mA (2 marks)

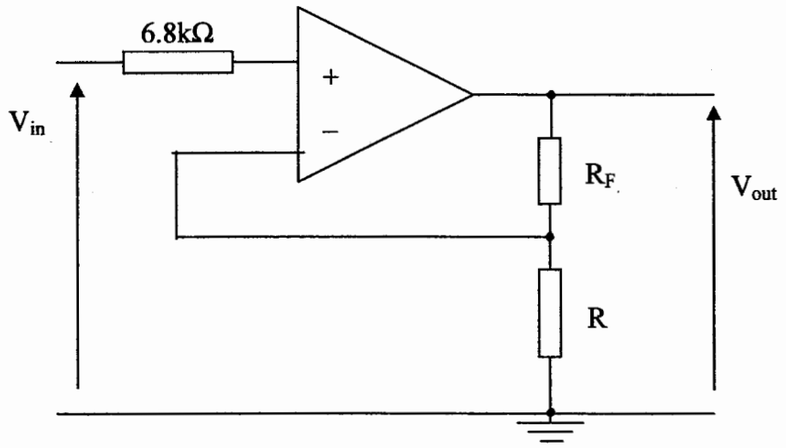
(b) With the aid of a suitable diagram, explain the operation of an n-channel JFET. (8 marks)

Question 3

(a) Give three reasons for using negative feedback in Op-Amp circuits (3 marks)

(b) Explain the following terms when used in association with Op-Amps (4 marks)
(i) open loop gain
(ii) input offset voltage

(c) Consider the following circuit



(i) What type of Op-Amp is this? (2 marks)
(ii) Given that the input voltage, V_{in}, is 6V, R_F = 10 kΩ and R = 20 kΩ, determine the output voltage, V_{out} (4 marks)

(iii) Derive an expression for the closed loop gain of the above amplifier. (4 marks)

(c) Design a circuit incorporating op-amps which would produce the following output;

$$y + 3\frac{dx}{dt} + 2\int x dt$$

(8 marks)

Question 4

(a)(i) Differentiate between diffusion current and drift current. (4 marks)

(ii) Briefly discuss the stages used to produce device fabrication ready wafers. (15 marks)

(b) Complete the following table of the BJT modes of operation (3 marks)

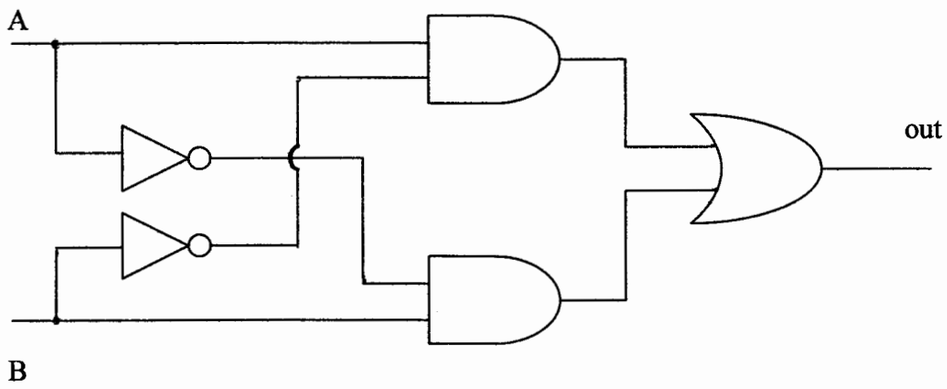
Mode	Emitter-Base junction	Common-Base junction
Cutoff		
Saturation		
Active		

(c) Explain the term "**Configuration**" when used in association with transistors and give one example (3 marks)

Question 5

(a)(i) State the difference between combinational logic and sequential logic (4 marks)

(ii) Work out the Truth Table of the following logic circuit and state what it does (or what it is called) (8 marks)



(b)(i) Simplify the following Boolean function

$$Z = ABC + AB\overline{C} + A\overline{B}C$$ (5 marks)

(ii) Design a logic circuit to implement the operation specified in the following Truth Table

(8 marks)

A	B	C	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0