BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT: ENGINEERING AND PHYSICS

PROGRAMME HBScED PHYSICS

COURSE CODE PH306 (1): ELECTRONICS 2

DURATION: 3 HOURS TOTAL MARKS: 100

INSTRUCTIONS TO CANDIDATES

Answer **question one** in Section A and **any three** questions from Section B. Section A carries 40 marks and each question in Section B carries 20 marks.

SECTION A

1 (a) Briefly describe the following states of a transistor.

(i) cut-off. [1]
(ii) saturation. [2]

(b) In a certain transistor, the transistor currents are given as I_C = 10 mA and I_B = 70 μA. Calculate I_E, α and β for this transistor. [6]

(c) An operational amplifier can be used as a differentiator. Derive its output voltage. [5]

(d) A sinusoidal voltage of peak value 10 μV and frequency of 2 kHz is applied as an input to an op-amp differentiator circuit. The values of the differentiating components are given as R = 40 $k\Omega$ and C = 3 μF. Determine the output voltage. [4]

(e) Prove the following expression using Boolean algebra:

$$\bar{A}BC + A\bar{B}C + AB\bar{C} + ABC = AB + BC + AC$$ [6]

(f) Determine the truth table for the circuit shown in Fig. 1.1 [4]

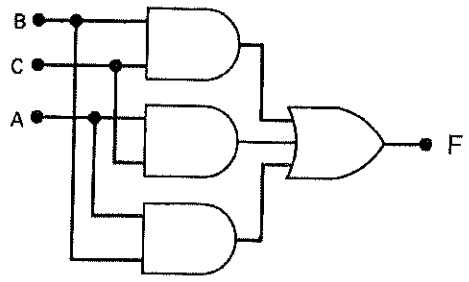

Fig. 1.1

(g) Construct a circuit that is equivalent to an EX-NOR gate using NAND gates only. [6]

(h) (i) What is meant by flip-flop? [2]
(ii) With the aid of a clearly labeled diagram, describe the operation of any one type of flip-flop. [4]

SECTION B

2 Consider the circuit shown in Fig. 2.1.

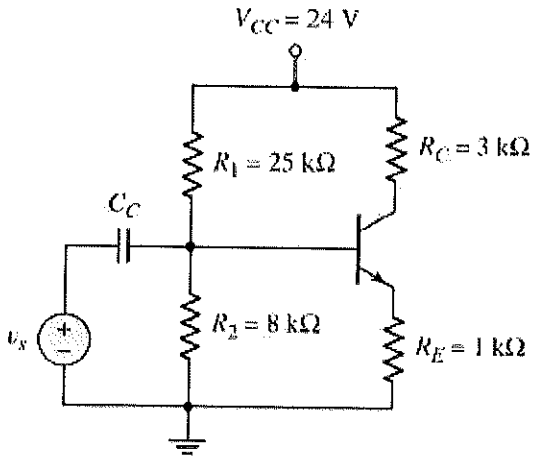

Fig. 2.1

Assuming $V_{BE(on)} = 0.7$ V, determine I_{BQ}, I_{CQ} and V_{CEQ} for:

(a) β = 75. [10]
(b) β = 150. [10]

3 (a) (i) Give any four characteristics of a real operational amplifier. [4]
(ii) Show that negative feedback reduces the gain of an operational amplifier. [5]

(b) (i) Explain what is meant by null-offset in operational amplifiers. [2]
(ii) Describe how null-offset is corrected. [3]

(c) Fig. 3.1 shows an op-amp circuit.

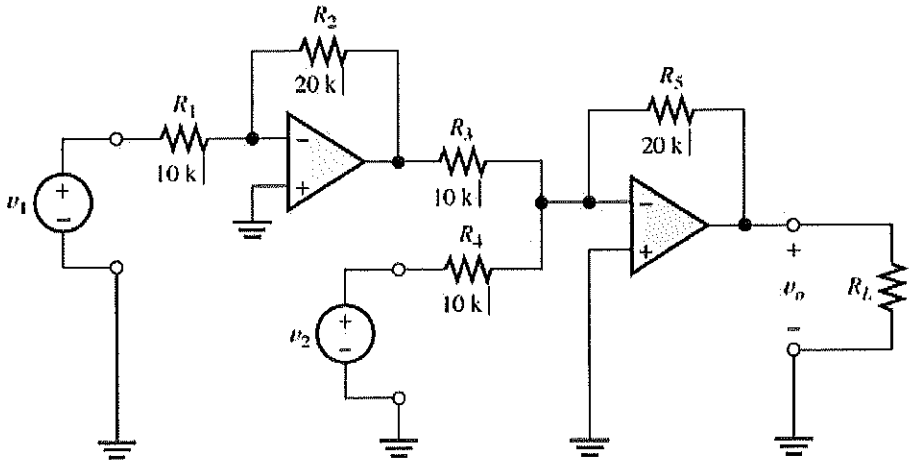

Fig. 3.1

Show that $v_o = 4v_1 - 2v_2$ [6]

4 An operational amplifier is connected in the circuit shown in Fig. 4.1. The switch S is open, the inverting input is at 0 *V* and the output voltage is $+V_0$.

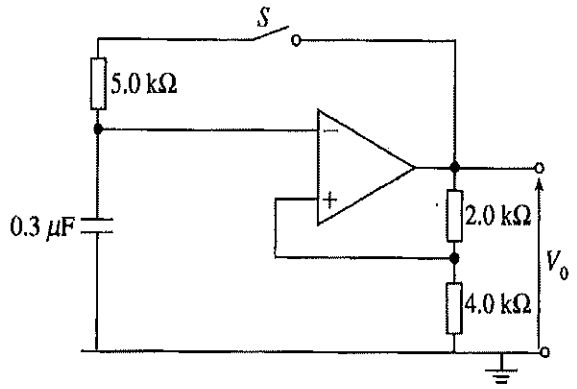

Fig. 4.1

(a) Find the potential at the non-inverting input in terms of V_0. [3]

(b) The switch S is then closed.

(i) Explain why the potential of the inverting input becomes progressively more positive. [3]

(ii) Calculate the time taken for the potential of the inverting input to reach the same potential as the non-inverting input. [4]

(iii) With the aid of graphs, describe and explain the subsequent variations in V_0. [10]

5 (a) Fig. 5.1 shows a logic circuit. Its truth table (incomplete) is shown in Table 5.1.

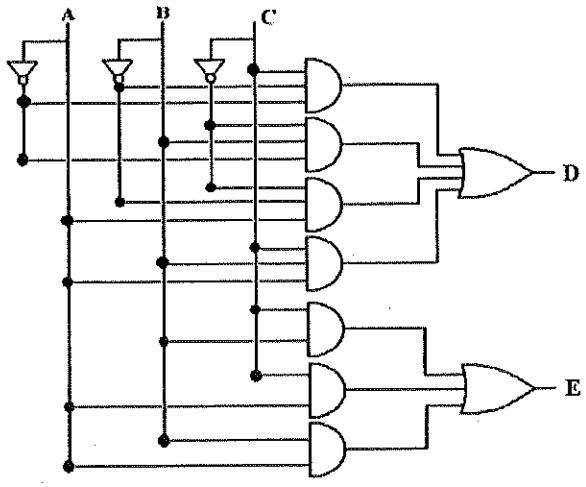

Fig. 5.1

Table 5.1

Input			Output	
A	B	C	D	E
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Copy and complete Table 5.1. [20]

6 The Table below is a truth table for a logic circuit.

Input A	Input B	Input C	Output Q
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

(a) Derive the Boolean function for the output Q. [5]
(b) Draw the logic circuit that produces the output Q in (a). [5]
(c) Hence, draw another circuit to show how the same output Q can be obtained using only two NOT gates, two AND gates and one OR gate. [10]

END OF PAPER