BINDURA UNIVERSITY OF SCIENCE EDUCATION

PHYSICS AND ENGINEERING DEPARTMENT

BSC (HONS) NETWORK ENGINEERING

PH206: ELECTRONICS 1

TIME: 3 HOURS

INSTRUCTIONS

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.

Physical constants

Electronic charge, e = 1.6 x 10^{-19} C
Boltzmann's constant, k = 1.38 x 10^{-23} JK^{-1}

SECTION A

1 (a)   Define the following as regards to semiconductor diodes:

   (i)   Biasing of diode.   [2]
   (ii)   Forward voltage.   [2]
   (iii) Reverse voltage.   [2]

   (b)   The ideal diode current equation relating the voltage V and current I is given by:

$$I = I_s \left[e^{\left(V/\eta V_T \right)} - 1 \right]$$

   where symbols have their usual meanings.

   (i)   Define the remaining symbols in the equation.   [3]
   (ii)   Calculate V_T at 298 K.   [3]

   (c)   A bipolar junction transistor (BJT) function is usually considered in terms of currents: a relatively small current through one of the transistor's terminals exerts control over a much larger current. Fig. 1.1 shows two transistors.
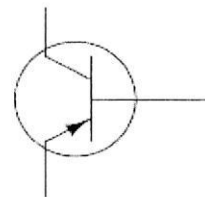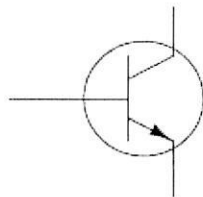

Fig. 1.1

Redraw Fig. 1.1 and

(i) Identify the NPN and PNP transistor and explain the difference between the two. [6]

(ii) Indicate the directions of all currents for these two transistors, clearly identifying which of the currents is doing the control, and which of the currents is being controlled: [6]

(d) Calculate I_E in a transistor for which $\beta = 50$ and $I_B = 20\ \mu A$. [4]

(e) In a common base connection, current amplification factor is 0.9. If the emitter current is 1mA, determine the value of base current. [6]

(f) What is meant by the CMRR of an operational amplifier? [2]

(g) What are differential gain and common-mode gain of a differential amplifier? [4]

SECTION B

2 Determine the currents I_1, I_2 and I_3 for the network shown in Fig. 2.1. [20]
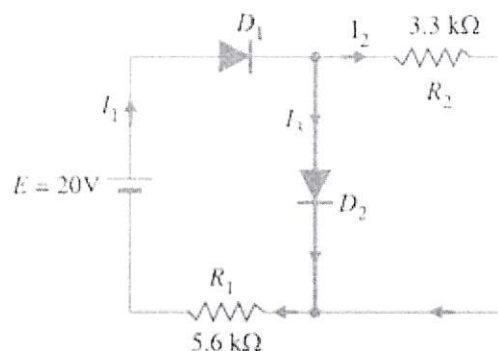

Fig. 2.1

3 Find the current through the diode in the circuit shown in Fig. 3.1.
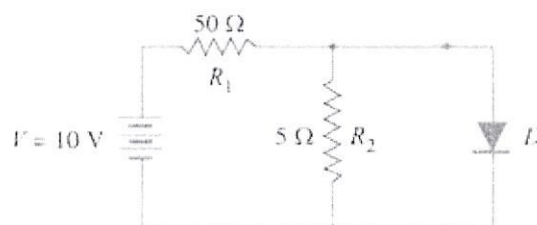Assume the diode to be ideal. [20]

Fig. 3.1

4   Determine I_B, V_{CE} and V_{CB} in the transistor circuit shown in Fig. 4.1. The transistor is
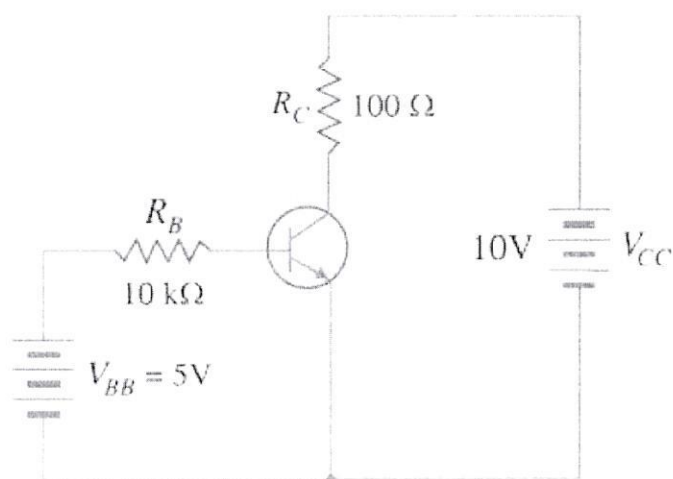   of silicon and has β = 150.   [20]

Fig. 4.1

5   Determine the Q point of the transistor circuit shown in Fig. 5.1. Also draw the d.c. load
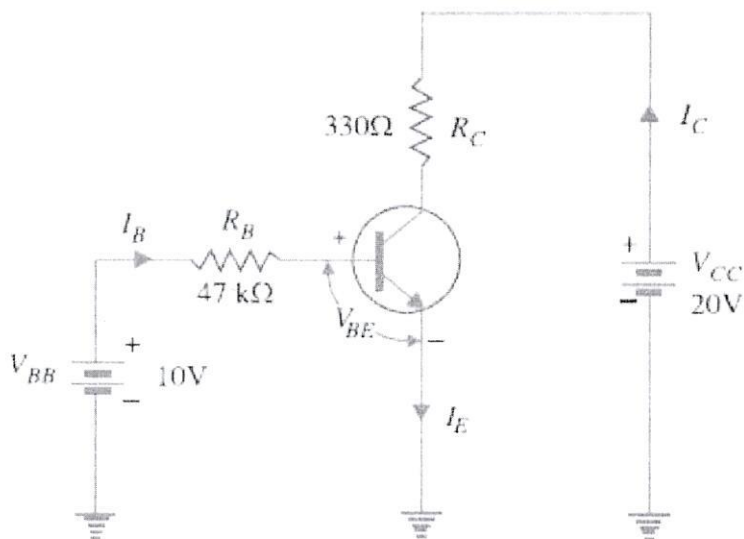   line. You are given that β = 200 and V_{BE} = 0.7 V.   [20]

Fig. 5.1

6   (a)   Give any four characteristics of an ideal operational amplifier.   [4]
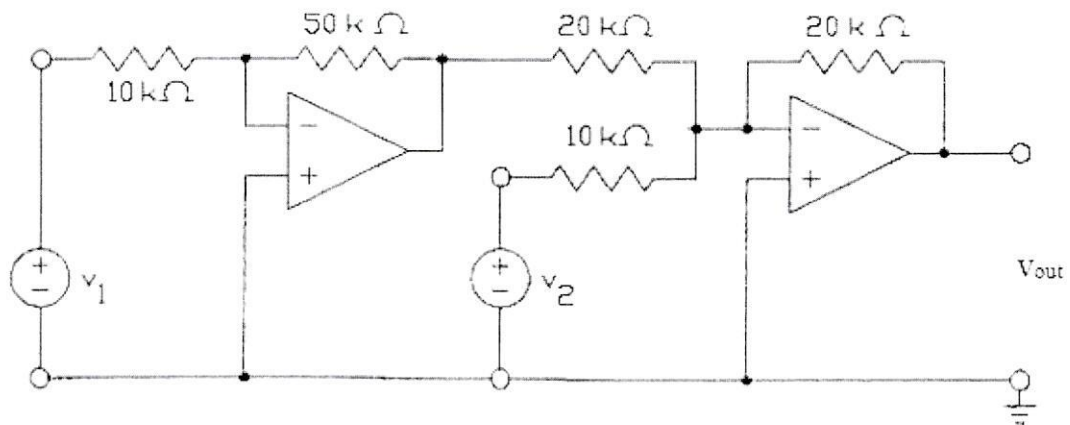
(b)   Fig. 6.1 shows an op-amp circuit.

Fig. 6.1

(i)   Obtain an expression of v_{out} in terms of v_1 and v_2.   [13]
(ii)   Hence calculate the value of v_{out} when $v_1 = 500$ mV and $v_2 = 25$ mV.   [3]

END OF EXAMINATION