2019

ELECTRONIC SCIENCE

Paper : ELCGE-31

(Electronics)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***any five*** questions.

1. (a) Define effective mass, carrier mobility and minority carrier life-time.

(b) Show the variation of mobility with temperature and explain its nature.

(c) How does the intrinsic carrier concentration vary with (i) temperature and (ii) band gap?

(d) Write down the current equation and continuity equation for holes in a semiconductor. 3+3+2+2

2. (a) Obtain expressions for electric-field and potential distributions in an abrupt *p-n* junction diode and discuss them. Also, obtain expressions for the depletion layer width and depletion layer capacitance for such a diode.

(b) Find contact potential of a diode if *p*- and *n*-side doping concentrations are 5×10^{16} cm^{-3} and 4×10^{17} cm^{-3}, respectively. Assume $n_i = 1 \times 10^{16}$ cm^{-3} and kT/q = 26 mV, where the terms have their usual meanings. 8+2

3. (a) What is meant by α and β of a transistor? Show that, $\beta = \dfrac{\alpha}{1-\alpha}$.

(b) What are the factors that affect the bias stability of a transistor?

(c) Design a CE collector-feedback bias circuit of an npn transistor to establish a quiescent operating point at $I_{CQ} = 1$ mA and $V_{CEQ} = 8$ V. Given that, $\beta = 100$, $V_{CC} = 12$, and $V_{BE} = 0.3$ V. 4+2+4

4. (a) Draw the r_e — model equivalent circuit of a transistor in CE configuration. Show that, $r_e = \dfrac{26\text{mV}}{I_E}$.

(b) Draw the low-frequency *h*-parameter equivalent circuit of a transistor operating in CE mode. State the *h*-parameters of the circuit.

(c) For the transistor amplifier of Fig. Q. 4.(c), determine Z_i, Z_o, A_v and A_i of the amplifier using approximate h-parameter model. Given that, $h_{ie} = 560\Omega$ and $h_{fe} = 120$. 3+4+3

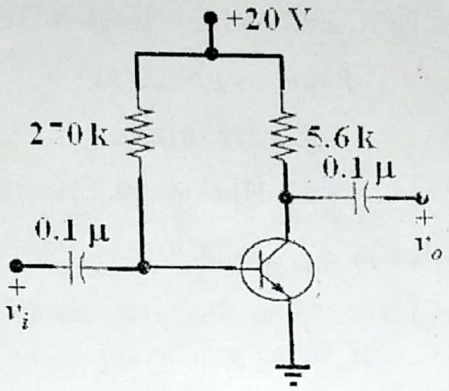

Fig. Q. 4 (c).

5. (a) Convert the decimal number 51926 into its hexadecimal equivalent.

(b) Subtract 11010 from 10110 using 2's complement method.

(c) Find the minimum expression for the function

$$F(X,Y,Z) = \bar{X}\,\bar{Y}\,\bar{Z} + \bar{X}\,\bar{Y}\,Z + \bar{X}\,Y\,\bar{Z} + \bar{X}\,Y\,Z + X\,Y\,\bar{Z}$$

using a Karnough map.

(d) Write down the truth table of a Full-adder. Write the canonical SOP forms for the sum and carry outputs. 2+2+3+3

6. (a) Explain the effect of negative feedback on signal-to-noise ratio.

(b) What is Barkhausen criterion?

(c) Show that for voltage shunt feedback, both the input and output impedance decrease.

(d) How is op-amp used as an integrator? 2+2+(2+2)+2

7. Draw the schematic structure and relevant band diagram of a metal-oxide-semiconductor (MOS) capacitor on p-Si substrate. Assuming an applied voltage varying from negative to positive across its terminals, explain how its capacitance will change. 3+7

8. Draw the schematic structure of a metal-oxide-semiconductor field effect transistor (MOSFET) and explain its operation with relevant current-voltage characteristics. Explain how threshold voltage and trans-conductance of such a device can be measured. 6+4