'समानो मन्त्रः समितिः समानी'

UNIVERSITY OF NORTH BENGAL

B.Sc. Honours 4th Semester Examination, 2022

CC10-PHYSICS

ANALOG SYSTEMS AND APPLICATIONS

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
All symbols are of usual significance.

GROUP-A

1. Answer any ***five*** questions from the following: 1×5 = 5

   (a) At a high temperature an extrinsic semiconductor behaves like an intrinsic semiconductor. — Explain.

   (b) For a certain transistor with $\alpha_{dc} = 0.98$ and emitter current $I_E = 2$ mA, calculate the base current.

   (c) What is the virtual ground of an operational amplifier?

   (d) What is the open loop gain of an operational amplifier?

   (e) What do you mean by the term 'avalanche breakdown' of a p-n junction diode?

   (f) What do you mean by the term *Q*-point of a transistor?

   (g) In a half wave rectifier, the peak value of the ac voltage across the secondary of the transformer is $20\sqrt{2}$ volt. If, no filter circuit is used, calculate the maximum dc voltage across the load.

   (h) Draw the voltage transfer characteristics (VTC) of a Schmidt trigger circuit.

GROUP-B

Answer any *three* questions from the following 5×3 = 15

2. (a) Explain the use of Zener diode as a voltage regulator with suitable circuit diagram. 4

   (b) Write down the voltage-current relation in a p-n junction diode in forward bias condition. 1

3. (a) Draw the energy-band diagram of a p-n junction diode and indicate the locations of donor level, acceptor level and fermi energy level in this diagram. 3

(b) Calculate the values of dc resistance and ac resistance of a germanium p-n junction diode at temperature 27°C for applied voltage 0.1 volt, reverse saturation current $I_0 = 20$ μA and ratio of Boltzmann constant to electric charge of an electron $= \frac{k_B}{e} = \frac{1}{11600}$. 2

4. (a) Draw the diagram of the voltage divider biasing circuit in transistor and derive the expression of the base current I_B. 3

(b) Show that the value of stability factor for the voltage divider biasing method approaches to unity. 2

5. (a) Show that negative feedback in amplifiers can improve the stability of an amplifier. $1\frac{1}{2}$

(b) Show that negative feedback can change the input impedance of an amplifier. $1\frac{1}{2}$

(c) Explain why common emitter configuration is preferred for amplifier design. 2

6. (a) Draw a net diagram of a RC-phase shift oscillator. 2

(b) Write down the expression for frequency of oscillation in RC-phase shift oscillator. (Derivation is not needed). 1

(c) Why three identical R-C sections are used in R-C phase shift oscillator? 2

GROUP-C

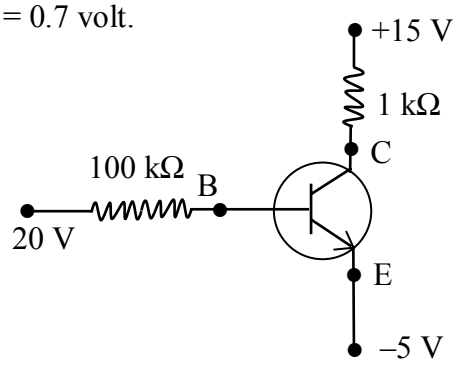
Answer any *two* questions from the following $10\times2 = 20$

7. (a) Draw and label the circuit diagram of a small signal single stage low frequency transistor amplifier in the CE mode. 2+1+1+1+2

Using the h parameters, obtain the expressions of current gain, input impedance, voltage gain and output impedance of this transistor amplifier.

(b) Calculate the values of I_B, I_C, I_E and V_{OE} for the transistor circuit given below. 3

Assume, $\beta = 50$, $V_{BE} = 0.7$ volt.



8. (a) Derive the expression of output voltage for inverting amplifier with proper circuit diagram. 4

(b) Why inverting amplifier circuit is also known as 180° phase shifter circuit? 1

(c) Show that the electrical mobility of the electrons in a semiconductor is $\mu = \frac{e\tau}{m^*}$, where the symbols have their usual meanings. 3

(d) What are the differences between Field Effect Transistor (FET) and Bipolar Junction Transistor (BJT)? 2

9. (a) Draw the circuit diagram of a full wave bridge rectifier using semiconductor diodes. 2+4

Find out the expressions of Ripple factor and Rectification efficiency of this full wave bridge rectifier.

(b) The band gap of a specimen of gallium arsenide phosphide is 1.98 eV. 2

Determine the wavelength of the electromagnetic radiation that is emitted upon direct recombination.

What is the colour of the emitted radiation?

(c) State and explain the Barkhausen criterion for an oscillator. 2

10.(a) Explain the operation of an OPAMP as a 3+3

(i) Differentiator

(ii) Integrator.

(b) What should be the input resistance, output resistance, voltage gain and band width of an ideal OPAMP? 2

(c) At the temperature 300 K, the intrinsic carrier concentration of silicon is $1.5 \times 10^{16}\ m^{-3}$. 2

If the electron and the hole mobilities are 0.13 $m^2v^{-1}s^{-1}$ and 0.05 $m^2v^{-1}s^{-1}$ respectively, determine the value of intrinsic resistivity of the silicon at temperature 300 K.

——×——