2022

(CBCS)

(5th Semester)

PHYSICS

SIXTH PAPER

(Electronics—I)

Full Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions

(SECTION : A—OBJECTIVE)

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. Conductivity of an intrinsic semiconductor is

(a) unaffected by temperature variation ( )

(b) affected by temperature variation and is directly proportional to temperature ( )

(c) affected by temperature variation and is indirectly proportional to temperature ( )

(d) affected by temperature till 300 K only ( )

2. A crystalline semiconductor has room temperature intrinsic carrier concentration of roughly 1 08 10^{10} cm ^{3} and there are approximately 5 10^{22} silicon atoms/cm^{3}. It is doped with pentavalent atoms with doping density of 10^{16} atoms/cm ^{3}. If mobilities of electrons and holes are 1500 cm^{2}V ^{1}s ^{1} and 475 cm^{2}V ^{1}s ^{1} respectively, then conductivity of the doped silicon is

(a) 1 6 C cm ^{1}V ^{1}s ^{1} ( )

(b) 3 6 C cm ^{1}V ^{1}s ^{1} ( )

(c) 2 4 C cm ^{1}V ^{1}s ^{1} ( )

(d) 16 C cm ^{1}V ^{1}s ^{1} ( )

3. If current in a certain electrical circuit is given by the expression

$$i \quad \begin{matrix} I_m \sin t ; & 0 & t \\ I_m ; & & t \quad 2 \end{matrix}$$

the root mean square current will be

(a) $\frac{I_m}{2}$ ( ) *(b)* $\frac{\sqrt{3}I_m}{2}$ ( )

(c) $\frac{I_m}{\sqrt{2}}$ ( ) *(d)* $\frac{I_m}{}$ ( )

4. The breakdown process in avalanche breakdown is due to

(a) inelastic collision of accelerated electrons and ions in the depletion region ( )

(b) dislodging of electrons from the ions caused by a strong electric field in the depletion region ( )

(c) elastic collision of accelerated electrons and ions ( )

(d) breaking up of covalent bonds in the bulk *p* and *n* regions ( )

5. In power transistor

(a) doping level of emitter and collector is high ( )

(b) ohmic resistance between emitter and base is decreased by decreasing the contact area ( )

(c) area of collector is large to dissipate the generated heat ( )

(d) ohmic resistance between base and collector is increased ( )

6. The function of a capacitor connected in parallel with the emitter resistance is to

(a) provide alternative path in the emitter circuit ( )

(b) filter out the d.c. component ( )

(c) shunt the emitter resistance for a.c. signal ( )

(d) provide emitter base biasing ( )

7. Phase-shift oscillator has advantage over Colpitts oscillator due to which of the following reasons?

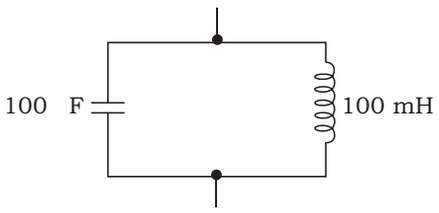
(a) It is simple and does not require inductor ( )

(b) It can be used to generate low frequency signal by choosing large resistors ( )

(c) It provides good frequency stability ( )

(d) All of the above ( )

8. The frequency of oscillation of the tank circuit



is

(a) 130 Hz ( ) *(b)* 145 Hz ( )

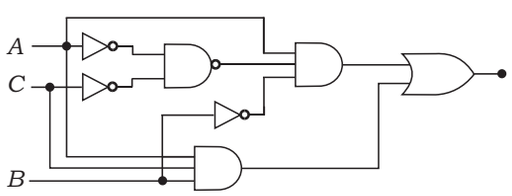
(c) 159 Hz ( ) *(d)* 360 Hz ( )

9. If V_1 and V_2 are the non-inverting and inverting inputs and V_0 is the output voltage, then the open-loop gain is

(a) $A_{OL} \quad \frac{V_0}{V_1 \quad V_2}$ ( ) *(b)* $A_{OL} \quad \frac{V_0}{V_1 \quad V_2}$ ( )

(c) $A_{OL} \quad \frac{V_0}{V_2 \quad V_1}$ ( ) *(d)* $A_{OL} \quad \frac{V_2 \quad V_1}{V_0}$ ( )

10. The simplified logic expression for the given logic diagram is



(a) $A.B \quad C$ ( ) *(b)* $A.B.C \quad \overline{A}.\overline{C}$ ( )

(c) $(A \quad B) \quad \overline{A}.\overline{C}$ ( ) *(d)* $A.(C \quad \overline{B})$ ( )

(SECTION : B—SHORT ANSWER)

(*Marks* : 15)

Answer the following : 3×5=15

UNIT—I

1. What are drift and diffusion currents? How do they differ from each other?

OR

2. Write down three applications of Hall effect.

UNIT—II

3. Explain how Zener diode can be used to regulate voltage fluctuation.

OR

4. Explain tunnel effect in a tunnel diode.

UNIT—III

5. What are class *A* and class *B* amplifiers? How do they differ from each other?

OR

6. Explain how voltage divider circuit can prevent thermal runaway.

UNIT—IV

7. Explain Barkhausen's criterion for self-sustained oscillations.

OR

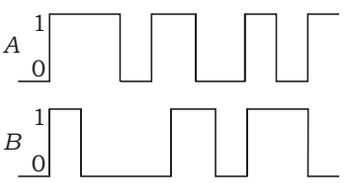
8. What is an emitter bypass capacitor CE in RC coupled amplifier? Explain its function.

UNIT—V

9. Distinguish between characteristics of an ideal op-amp and IC 741.

OR

10. Trace the output of NAND gate, if the two inputs *A* and *B* are as shown below :



(SECTION : C—DESCRIPTIVE)

(*Marks* : 50)

Answer the following : 10×5=50

UNIT—I

1. Derive diode equation. Draw IV characteristics of *P-N* junction diode and correlate with the diode equation. 6+4=10

OR

2. Explain the formation of space charge region (depletion region) in a *P-N* junction diode. Obtain the expression for barrier width (depletion width)

$$W \quad \sqrt{\frac{2\ V_B}{e}\ \frac{1}{N_a}\quad \frac{1}{N_d}}$$

where V_B is the barrier built in potential, N_a and N_d are acceptor and donor densities, respectively. Also discuss how the depletion width changes under forward and reverse bias conditions. 3+5+2=10

UNIT—II

3. Draw the circuit diagram for bridge rectifier and explain its working. Obtain the expressions for d.c. (average) current and r.m.s. current. Show that the power conversion efficiency and ripple factor in full-wave rectifier are 81·2% and 0·48, respectively. 3+4+3=10

OR

4. *(a)* Explain how the circuit elements—capacitor and inductor function in designing filter circuits. Draw the circuit diagram of both C filter and pi filter. Discuss their performance. 4+2=6

(b) Explain the principle and working of photodiode. 4

UNIT—III

5. *(a)* Draw the circuit diagram of *n-p-n* transistor in CE configuration. Explain its input and output characteristics. 2+4=6

(b) Explain transistor DC load line and operating point. 4

OR

6. Explain the hybrid parameters method of analyzing two-port linear circuits. Show that a single-stage CE amplifier can be analyzed using hybrid parameters approach. Obtain the *h*-parameters equivalent circuit diagram in terms of transconductance. Also obtain the expressions for current gain, voltage gain, input resistance and power gain. 3+2+5=10

UNIT—IV

7. *(a)* What are positive and negative feedbacks in an amplifier circuit? Deduce the general expression for gain with negative feedback in terms of gain without feedback. Also explain how negative feedback stabilizes the gain of an amplifier. 1+3+2=6

(b) Explain the working of RC coupled amplifier at low frequency. 4

OR

8. What are sinusoidal oscillators? Explain with diagram the working of Hartley and Colpitts oscillators. 2+4+4=10

UNIT—V

9. *(a)* Draw the circuit diagrams for op-amp in inverting and non-inverting closed-loop configurations. Deduce the expressions for voltage gain in both the cases. 5

(b) Draw the circuit diagram for basic differentiator op-amp. From the circuit, deduce the relation between output voltage and input voltage. 5

OR

10. *(a)* State the two De Morgan's theorems. Using sum of product rule, obtain the simplified Boolean expression for the truth table given below : 2+3=5

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	0	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

(b) Use 2's complement method to perform binary subtraction of decimal number 5 from 19. 3

(c) What do you mean by slew rate of an op-amp? 2

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