2023

PHYSICS — HONOURS

Paper : CC-9

(Syllabus : 2019-2020)

(Analog 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 ***question no.*** **1** and ***any four*** questions from the rest.

1. Answer ***any five*** questions : 2×5

(a) State and explain Reciprocity theorem.

(b) Why is there a reverse saturation current in a p-n junction? Does it vary with reverse bias and temperature?

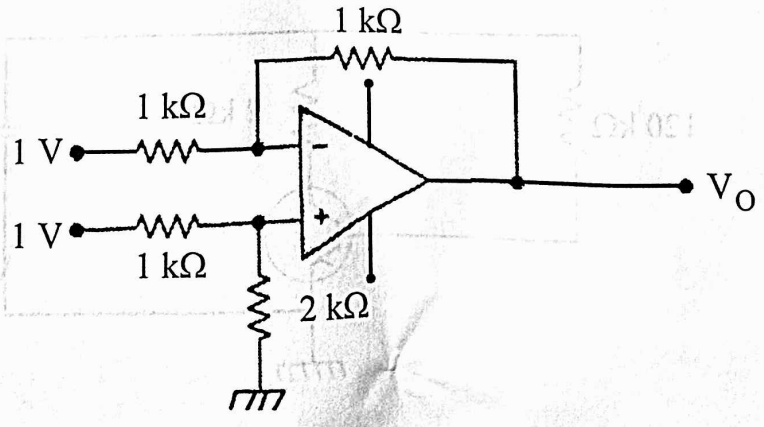
(c) Why is the base region least heavily doped in a BJT?

(d) What do you mean by a pinch-off condition of JFET?

(e) A BJT is a current controlled device and a FET is voltage controlled device. Explain.

(f) Explain Barkhausen's criterion for self-sustained oscillation.

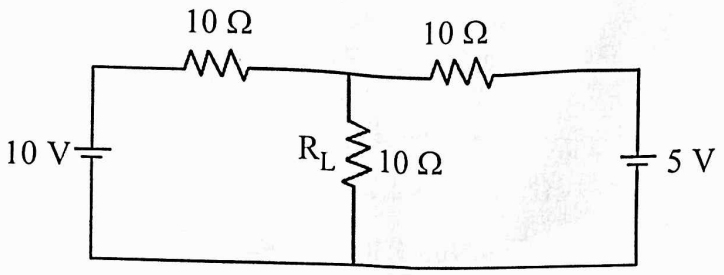
(g) What is the output of the following circuit?



2. (a) State and explain Thevenin's theorem.

(b) State Superposition theorem.

(c) Using superposition theorem, find current through R_L. Verify the current using Thevenin's theorem.

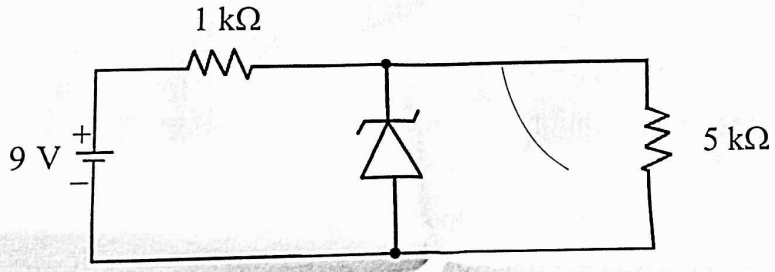


(2+1)+2+(3+2)

3. (a) A pure semiconductor has intrinsic current density of $10^{20}/m^3$ at 300K. When doped with donor type impurities, hole concentration decreases to $10^{18}/m^3$ at the same temperature. Find the value of electron density.

(b) Draw the energy band diagram of an open circuited p-n junction.

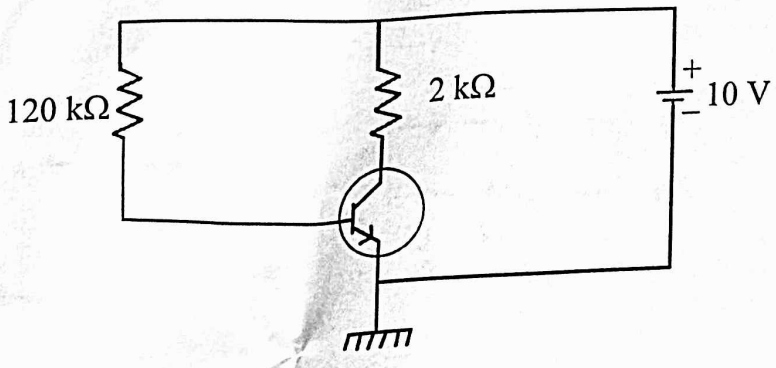
(c) In the circuit diagram, what are the currents flowing through 1 kΩ and 5 kΩ resistances and the Zener diode? What happens when the resistances are interchanged their positions? Breakdown voltage of Zener diode is 6.0 V.



(d) Explain the principle of operation of a photodiode. 2+2+4+2

4. (a) Define α and β of a transistor. Find the relation between them.

(b) In the circuit, the transistor has β = 100. Determine the region of operation and the value of I_B, I_C and V_{CE}. Consider $V_{BE} = 0.7$ V.



(c) Explain how self-bias circuit ensures stability of Q point. (2+2)+4+2

5. (a) Explain how voltage gain is stabilized with the application of negative feedback.

(b) The open loop gain of an amplifier is 100. What will be the overall gain when a negative feedback of 0.6 is applied to the amplifier?

(c) What is meant by threshold voltage of a MOSFET?

(d) Draw the circuit diagram of a CS JFET amplifier. The load resistance, ac drain resistance and the transconductance of the JFET amplifier are 500 kΩ, 100 kΩ and 0.2×10^{-3} A/V respectively. Obtain voltage gain of the amplifier. 2+2+2+(2+2)

6. (a) What is the significance of virtual ground in operational amplifier?

(b) Draw the circuit diagram of Schmidt trigger and explain its operation.

(c) A ramp voltage of 1.5 V/m is applied on an OP AMP differentiator with R = 2 kΩ and C = 0.01 μF. Find the output voltage.

(d) Compare ideal and practical characteristics of OP AMP. 2+4+2+2

7. (a) A Wien bridge oscillator is to be constructed at frequency 10 kHz. If the capacitance of the circuit be 500 pF, find the resistance used in the circuit. Draw the necessary circuit diagram.

(b) Explain briefly the function of Astable multivibrator and write down the expression for time period.

(c) Write down the expression for frequency of a phase shift oscillator. What is the minimum value of gain of the amplifier for sustained oscillation? 3+4+3