M.Sc. Semester-III Examination (Under CBCS), 2020

UNIVERSITY OF CALCUTTA

ELECTRONIC SCIENCE

Paper : ELCGE-31

(Electronics)

Full Marks : 50

Total Time – 2 Hours

INSTRUCTIONS TO THE EXAMINEE

(A) Use blank white paper sheets to write down the answers in your own hand writing. Note that no computer-typed answer scripts will be considered for evaluation.

(B) Write down the following on the first page of your answer scripts:

M.Sc. Semester-III Examination (Under CBCS), 2020

Roll No.:-

Registration No.:-

Date of Examination:-

Paper/Course Code:-

Paper/Course Name:

Total no. of pages used (including this page):-

(C) You must write your roll number and page no. on the top margin of each page of your answer scripts.

(D) Write your answers mentioning the appropriate question no. starting from the second page onward.

(E) After completion of the examination **at 2:00 pm**, submit the scanned copies or images of all the pages of your answer scripts making "preferably a **single pdf** file or images in **jpeg** format" in digital mode via e-mail **within 2:20 pm**.

(F) File name of your answer scripts should preferably be: **XXYY.pdf/jpg** and submit your answer scripts to the following e-mail ids: **akelc@caluniv.ac.in, abhijit_mallik1965@yahoo.co.in, scelc@caluniv.ac.in, jselc@caluniv.ac.in,** with a copy to your Head/Principal.

Note-1: **XX** is the abbreviation of your Department/College name.
YY is the last two digits of your roll no.
XX is **PH** for students of the Department of Physics, CU
XX is **AM** for students of the Department of Applied Mathematics, CU
XX is **GC** for students of the Gurudas College
XX is **VC** for students of the Vivekananda College

Note-2:

Question Paper Upload Time	**: 11:50 AM**
Examination Start Time	**: 12:00 Noon**
Examination End Time	**: 2:00 PM**
Answer Scripts Upload Time	**: 2:20 PM**

You must follow and abide by these above-mentioned instructions and timing.

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2020

ELECTRONIC SCIENCE

Paper : ELCGE-31

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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 and mobility.
   (b) Give an account of the variation of the carrier concentration with temperature for an *n*-type semiconductor.
   (c) How does the carrier mobility in a bulk semiconductor vary with temperature and why?
   (d) Calculate the resistivity of an *n*-type silicon doped with 10^{17} phosphorus atoms/cm^3. Assume $q = 1.6\times10^{-19}$ C and $\mu_n = 1200$ cm^2/V.s. 2+3+3+2

2. (a) Derive an expression for the contact potential in a *p-n* junction diode.
   (b) Calculate the contact potential for a *p-n* junction with $N_A = 10^{18}$ cm^{-3} and $N_D = 10^{15}$ cm^{-3} at room temperature. Given: $kT/q = 25.9$ mV and $n_i = 9.65\times10^9$ at room temperature, where the terms have their usual meanings.
   (c) Calculate the reverse saturation current in a Si *p-n* junction diode with cross-sectional area of 2×10^{-4} cm^2. Assume: $N_A = 5\times10^{16}$ cm^{-3},$N_D = 10^{16}$ cm^{-3}, $n_i = 9.65\times10^9$cm^{-3}, $D_n = 21$ cm^2/s, $D_p = 10$ cm^2/s, and$\tau_n = \tau_p = 5\times10^{-7}$s, where the terms have their usual meanings.
   (d) What is diffusion capacitance? 3+2+4+1

3. (a) Show the experimental set-up to draw the input and output characteristics of a transistor operating in the *CC* configuration. Sketch the input characteristics and explain the nature of the curve qualitatively. Sketch the output characteristics indicating the active, saturation and cutoff regions.
   (b) "The value of α increases with the increasing reverse bias voltage of the collector-base junction." – Why?
   (c) What are the factors that affect the bias stability of a transistor circuit? Give the mathematical expressions of different stability factors.
   (d) In a fixed bias circuit of transistor, $V_{CC} = 15$ V, $R_B = 300$ kΩ and $R_C = 2$ kΩ. If $\beta = 100$, $I_{CO} = 20$ nA and $V_{BE} = 0.7$ V, determine the *Q*-point and find the thermal stability factor of the bias circuit. 4+1+2+3

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4. (a) What is a load line? Explain its significance.
   (b) Define the hybrid parameters for a basic transistor in any configuration.
   (c) A *CE* transistor amplifier is characterized by h_{ie} = 2 kΩ,h_{re} = 2×10^{-4}, h_{fe} = 50, and h_{oe} = 2×10^{-6}℧.If the load resistance is 4 kΩ and the source resistance is 200 Ω, determine the current gain and input impedance. Deduce the formulae you use. 2+3+5

5. (a) What is a junction field effect transistor (JFET)? With an appropriate diagram explain the operation of a JFET. How does the current in such a device saturate? Define trans-conductor of such devices.
   (b) Explain how inversion occurs in a metal-oxide-semiconductor (MOS) capacitor. (1+3+2+2)+2

6. (a) Draw the schematic of a metal-oxide-semiconductor field effect transistor (MOSFET) and label its different regions. Explain how pinch-off occurs in such a device.
   (b) Define threshold voltage of a MOSFET and explain how it can be measured? How does it depend on the substrate doping? What is the need of scaling down of MOSFETs? (1+3)+(4+2)

7. (a) How does negative feedback affect the stability and sensitivity of a circuit?
   (b) A 5 mV, 1 kHz sinusoidal signal is applied to the input of an OP-AMP integrator circuit with R = 100 kΩ and C = 1μF. Find the output voltage.
   (c) Name and draw the configurations of the four feedback topologies. 3+3+4

8. (a) Subtract 111 from 1101 using 1's complement method.
   (b) Explain the operation of a JK-flip flop using NAND gates.
   (c) What is priority encoder?
   (d) Draw the circuit diagram of a 4-bit ripple counter along with its timing diagram. 1+3+3+3

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