BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BE **SEMESTER : III**
BRANCH: ECE **SESSION : MO/18**

SUBJECT: EC3205 SEMICONDUCTOR DEVICES

TIME: 3 HOURS **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Relate energy and wave vector and translate their relationship through E-K diagram. [2]

Q.1(b) Describe effective mass of an electron? Express effective mass of an electron in terms of Planck's constant and its energy. [4]

Q.1(c) Represent the energy band of (a) intrinsic, (b) n-type and (c) p-type semiconductor in the form of diagram and show the plot of Fermi-Dirac distribution function by turning it counter clockwise. [6]

Q.2(a) Interpret the physical meaning of diffusion length? [2]

Q.2(b) Explain how steady state distribution of excess holes causes diffusion, and therefore a hole current (density), in the direction of decreasing concentration. [4]

Q.2(c) Explain how drift velocity and hole mobility can be calculated using Hynes-Shockley experiment? Substantiate your answer with suitable diagram. [6]

Q.3(a) Explain why electric field, E, is maximum at metallurgical junction of a p-n junction? Illustrate with suitable diagram. [2]

Q.3(b) The process of adding recombination centers to the bulk material cannot be continued indefinitely. Interpret this statement. [4]

Q.3(c) Deduce the expression for contact potential. [6]

Q.4(a) In many applications light from a laser or an LED need not be visible to the eye. Show an example of such an application. [2]

Q.4(b) Choose the most important figure of merit for a photodetector. Write down its expression. [4]

Q.4(c) Write down the expression of maximum power delivered to a load by solar cell. A Si solar cell has a short-circuit current of 100 mA and an open-circuit voltage of 0.8 V under full solar illumination. The fill factor is 0.7. Determine the maximum power delivered to a load by this cell. [6]

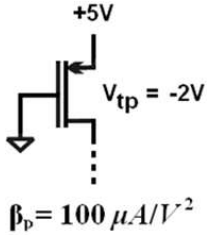
Q.5(a) Express base-to-collector current amplification factor, beta (ß), in terms of current transfer ratio, alpha (α). [2]

Q.5(b) Diagram simplified p-n-p transistor geometry along with band diagram in normal active mode. [4]

Q.5(c) Diagram the current-Voltage (I-V) characteristics of an *n-p-n* transistor and identify its three regions. [6]

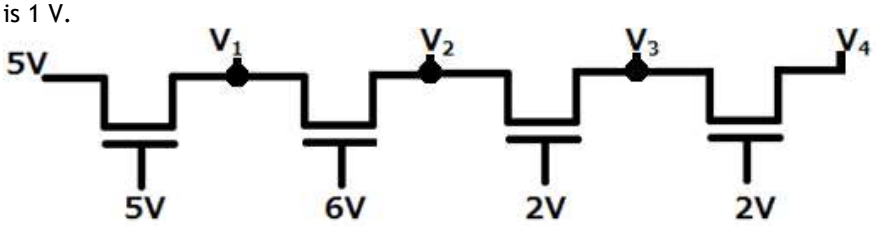
Q.6(a) Estimate φ_{MS} for $N_A = 10^{16}$ cm^{-3}, $n_i = 1.45 \times 10^{10}$ cm^{-3} and $\varphi_S = 2\,\varphi_F$. The gate material is n-type polysilicon with $N_D = 10^{20}$ cm^{-3}. [2]

Q.6(b) The source voltage, threshold voltage and gain factor are given in figure shown below. Estimate the highest voltage that can be applied to the drain while the device operates in saturation region. Neglecting the channel length modulation effect (i.e., λ = 0), estimate its drain current for $V_D = -5$ V. [4]



PTO

Q.6(c) Estimate the voltages V_1, V_2, V_3, V_4 in the figure given below. Assume that the threshold voltage of all the devices is 1 V. [6]



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Q.7(a) Write down the names of various types of charge-coupled devices. Briefly write about them. [2]

Q.7(b) Schematize a cross sectional view of basic MOS capacitor that may be used for CCD. Explain what happens if $V_{GS} < V_t$? Explain what if $V_{GS} > V_t$? Explain where the electrons for the inversion layer come from. [4]

Q.7(c) Schematize impurity concentration profile for fabricating a p-n junction from originally n-type sample by diffusion and point out the p-n junction in the diagram. [6]

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