B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING

FOURTH YEAR, SECOND SEMESTER EXAM, 2018

ADVANCED ELECTRON DEVICES **Time: Three hours** **Full Marks: 100**

Use a separate Answer-Script for each Part (50 marks for each Part)

PART-I

1. What are the different noise sources associated with an APD. With the help of simple model of photodetector receiver and its equivalent circuit determine the SNR of an APD receiver. What are the conditions to achieve high SNR? [3+15+2]

2. Answer any *two* from the following : [2×10=20]
   a) Draw basic structure of HBT and briefly explain its operation. Why no strain is introduced in AlxGa1-xAs/GaAs structure. [8+2]
   b) With the help of basic MESFET structure qualitatively describe its operation. Clarify why MESFETs can be used at high frequency. [8+2]
   c) Discuss the advantages of SAGM over SAM APD structure. What composition of $Al_xGa_{1-x}As$ is needed for an APD to be used at 0.68 μm cut-off wavelength? [5+5]

3. An n-channel GaAs (affinity =4.07 eV) MESFET has a channel doping of 2×10^{15}/cc. Gate is formed by a metal of work function 4.87 eV. The length, width and thickness of GaAs epitaxial layer are 1 μm, 10 μm and 0.5 μm, respectively. Find the pinch-off voltage, threshold voltage, saturation current and transconductance at saturation at V_G=0 V. [10]

[Turn over

Ref. No. : Ex/ET/T/425B/2018

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PART-II

Question 3 and 4 are mandatory.

1. Answer any two from the following : [2×05=10]

(a) What is quantum confinement effect and based on the confined dimension describe one dimension (1D), two dimension (2D) and three dimension (3D) structures. (2+3)

(b) State two main requirements to join two materials perfectly in an ideal heterostructure and Use Anderson's rule to estimate the discontinuities in the conduction band and valance band for two lattice matched systems such as $GaAs/Al_xGa_{1-x}As$, where $x = 0.30$
Band gap and electron affinities values are given by
E_g (GaAs) = 1.42 eV, χ (GaAs) = 4.07 eV, χ ($Al_{0.3}Ga_{0.7}As$) = 3.74 eV (2+3)

(c) What is superlattice structure? Why it is so named? What are difference between a multiple quantum well (MQW) and a superlattice structure? (2+1+2)

2. Answer any two from the following: [2×10=20]

(a)What is a carbon nanotube (CNTs)? Mention different types of CNTs, discuss their properties. (3+2+5)

(b) What is Single Electron Transistor (SET)? Draw the schematic and explain operation of a SET. (3+2+5)

(c) What is resonant tunneling diode (RTD)? Draw and explain with the help of appropriate band diagram, established the I-V characteristics of a RTD. (3+7)

3. (a) Describe the scheme for finding out energy states for an electron confined in a potential well of finite barrier height. (6)

(b) Show that the density of states (DOS) for free electrons in two dimensions (2D) are given by $N_{2D}(E) = m/\pi\hbar^2$ (4)

4. What is modulation doping; Draw and explain the structure of a FET based on the above principle and also mention its applications. (5+3+2)