

B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING, 2019
FOURTH YEAR SECOND SEMESTER
ADVANCED ELECTRON DEVICES

Full Marks : 100

Time : Three hours

Answer Q.1 and any SIX from the rest.

(All parts of the same question must be answered together)

1. Write note on any ONE of the following: 10
 - (a) Classification of heterojunctions,
 - (b) Real space transfer of electrons,
 - (c) Quantum cascade laser.

- 2.(a) Two semiconductors A and B are mixed via an appropriate growth technique. Classify the resulting alloy on the basis of atomic arrangement in it. Also describe the role of bond energies between neighboring atoms in determining the nature of the alloy. 6+5
- (b) What is *Virtual crystal approximation*? 4

3. Write down the general expression for DOS function in bulk semiconductor (no derivation). Derive the DOS functions and sketch their variations with energy for semiconductor QW and QWW. 1+5+7+2

4. Describe how a Multiple QW structure can be converted to a Superlattice (SL), and discuss the basic differences in their energy band structures. Why it is called Superlattice? Also compare the features of a *Compositionally graded SL* and *Doping SL*. 3+3+2+7

- 5.(a) What is stimulated emission of radiation? What are the fundamental conditions for *lasing* to occur? Describe how these conditions are met in a basic semiconductor laser diode. 2+3+6
- (b) Calculate the temperature at which room-temperature value of the threshold current doubles for a DH laser with $T_0 = 110^{\circ}C$. 4

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- 6.(a) Describe the inherent limitations of conventional doping and explain how they are overcome using *Modulation doping*. 8
- (b) Describe the structure of a MODFET obtained using Recess-gate technology. 7
7. Explain how the demands for a high performance switch contradict each other in case of a BJT. Also describe how they can be achieved in a single heterojunction bipolar transistor (SHBT). 6+9
8. Explain the I - V characteristics of a *Resonant tunneling diode* with the help of appropriate energy band diagrams. What is the *figure of merit* of such diode? How can it be improved? 10+1+4
9. Describe what an *Exciton* is. Explain how in a QW the excitonic absorption varies with an electric field applied along the confining dimension of the well. Also describe how an optical switch works on the basis of above phenomenon. 4+4+7