

ELECTRONICS AND COMMUNICATION ENGINEERING DEPARTMENT  
End Semester Examination, December 2006  
M.E. (VLSI Design & CAD)- 1st Year

7

Time Allowed : 3 Hours

Max. Marks : 45

Note : Answer any five questions.

- QNo.1 a) State and explain the three important cases for movement of free electrons inside a crystal lattice. Which one is closest to electron motion inside a semiconductor and why?  
b) If  $\rho_e = f(E) N(E)$  where the symbols have their usual significance. Establish the relation  $\rho_e = \gamma E^{1/2}$  for  $E < E_F$ , where  $\gamma$  is a constant. (5+4)
- QNo.2 Derive an expression for the Fermi level of an extrinsic semiconductor as a function of intrinsic Fermi level  $E_{Fi}$  and material doping levels. Under what conditions the two Fermi levels coincide. (6+3)
- QNo.3 Draw the energy band diagram of a Schottky Barrier diode and obtain an expression for the device capacitance. Why  $V_{D0}$  can not be evaluated by making measurements under forward bias? (6+3)
- QNo.4 a) Prove that for a p-n junction under thermal equilibrium the Fermi level must be a constant with respect to distance  $x$  across the device.  
b) Solve the Poisson's equation for a p-n junction and obtain an expression for the depletion region width "W". How will W be modified for an abrupt junction with  $N_D \gg N_A$ ? (4+5)
- QNo.5 a) Draw the biasing circuit, depletion region profiles and the energy band diagram of a BJT under normal bias. Hence show how you can derive expressions for emitter current and collector current of a BJT.  
b) If the transistor current gain  $\alpha_0 = M\gamma\alpha_T$ , show when  $\alpha_0 \rightarrow \infty$  and (ii)  $\alpha_0$  for  $V_{CB}$  below breakdown voltage of C-B junction. (7+2)
- QNo.6 a) Draw the structure of an n-channel enhancement mode MOSFET and explain its operation. What is channel length modulation and how does it affect the device characteristic and shape of the channel?  
b) Show that the MOSFET drain current is linearly related to the drain voltage for  $V_{DS} \rightarrow 0$  and varies non-linearly for  $V_{DS} \leq V_{DS\text{ sat}}$ . (6+3)
- QNo.7 Write short notes on any two of the following :-  
a) Degenerate Semiconductors  
b) Webster effect in BJT's  
c) MOSFET capacitances and breakdown (4 1/2 + 4 1/2)