PG/IIS/ELC-204/12

M.Sc. 2nd Semester Examination, 2012

ELECTRONICS

(*Semiconductor Devices*)

(Theory)

PAPER – ELC-204

Full Marks : 50

Time : 2 hours

Answer **Q.No.1** and any **three** from the rest

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

1. Answer the following questions : 2 × 5

   (*a*) Draw the small signal equivalent circuit model of a MESFET.

(*b*) In a metal-semiconductor contact, in the presence of surface states, discuss the Fermi level pinning effect.

(*c*) What do you mean by quali Fermi level of electron and holes of a *P-N* junction.

(*d*) How can you determine donor concentration of the semiconductor from the *C-V* measurement of a metal-*n* type semiconductor contact.

(*e*) Draw the Eber-Moll model of a transistor and write down the expression of emitter, Bare and collector current from the model.

2. (*a*) Derive the expression of shock by equation in connection with *P-N* junction Diode.

$$J_{SAT} = \frac{qD_p P_{n0}}{L_p} + \frac{qD_n n_{p0}}{L_n}.$$

(*b*) Prove that for relatively low frequencies the diffusion capacitance of a *P-N* junction

$$G_{do} = \frac{q}{kT}\left(\frac{qD_p P_{n0}}{L_p} + \frac{qD_n n_{p0}}{L_n}\right) e^{qv_0 / kT}$$

Where symbols have their usual significance. 6 + 4

3. (*a*) For a ideal metal semiconductor contact prove that $q(\phi_{Bn} + Q_{Bp}) = Eg$, where the symbols have their usual meaning.

(*b*) How can you determine the barrier height of a metal-semiconductor contact from current voltage measurement?

(*c*) Discuss, why activation energy method is preferred rather than current voltage measurement method to determine barrier height of a M.S contact?

(*d*) Define the term neutral level in connection with a metal semiconductor contact. 3 + 3 + 2 + 2

4. (*a*) For a metal semiconductor field effect transistor (MESFET) considering field dependent mobility approach, prove that the expression of drain current can be given as

$$I_D = \frac{I_p [3(u_2^2 - u_1^2) - 2(u_2^3 - u_1^3)]}{1 + \mu V_D / v_s L}$$

where u_1 and u_2 are the normalised depletion layer width at the source and drain end respectively.

(*b*) For a MESFET operated under the velocity saturation model prove that the mutual conductance can be given by

$$g_m = v_s z t_s / h(v_g)$$

where the symbols have their usual meaning. 8 +

5. (*a*) For a silicon controlled rectifier prove that the Anode current

$$I_A = \frac{Ico_1 + Ico_2 + \alpha_2 I_g}{1-(\alpha_1 + \alpha_2)},$$

the symbols have their usual meaning

(*b*) How can you determine *h* parameters of a transistor from its characteristics curves ? 6 +

6. (*a*) What is the image fore induced lowering of potential energy for charge carrier emission of a Schottky diode ? Prove that

$$\Delta\phi = \sqrt{\frac{qE}{4\pi \in \in_0}}$$

where the symbols have their usual meaning.

(*b*) Considering thermionic emission theory of a Schottky diode prove that

$$\phi_{Bn} = \frac{kT}{9} \ln\left(\frac{A^{**}T^2}{J_s}\right)$$

at zero bias, where the symbols have their usual meaning. 5 + 5

[*Internal Assessment* – 10 Marks]