PG/IIS/ELC-204/13

M.Sc. 2nd Semester Examination, 2013

ELECTRONICS

(*Semi-conductor Devices*)

(Theory)

PAPER – ELC-204

Full Marks : 40

Time : 3 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. (*a*) What do you mean by the Gummel number of a transistor ?

(*b*) What do you mean by Normally 'ON' and Normally 'OFF' MESFET.

(*c*) Prove that at thermal equilibrium the Fermi level must be constant through out the sample in a P-N junction diode.

(*d*) How can you determine the 'barrier height' of a schottky diode from 'activation in energy' measurement ?

(*e*) Determine doping concentration N_D of the semi-conductor side of a metal-*n* type schottky diode from junction capacitance. 2 × 5

2. (*a*) Derive the expression of built-in-potential and depletion layer width of a P-N junction diode.

(*b*) State the Eber-Moll equations of a P-N-P transistors for emitter, collector and base current. And from these equation draw the Eber-Moll model. (3 + 3) + (2 + 2)

3. (*a*) Derive the expression of shockley equation in connection with P-N junction diode

$$J_S = \frac{qD_p P_{no}}{L_p} + \frac{qD_n n_{po}}{L_n}$$

where the symbols have their usual meanings.

(*b*) Discuss different break down mechanism associated with the P-N junction diode. 7 + 3

4. (*a*) Derive the expression of thermo-ionic current density of a schottky function diode.

$$J = J_{ST}\left(e^{qv/KT} - 1\right)$$

where $J_{ST} = A^* T^2 \exp\left(-\frac{q\phi_{Bn}}{KT}\right)$

The symbols have their usual meanings.

(*b*) In which condition does the tunnelling current become important ? 8 + 2

5. (*a*) Discuss why dipole layer is formed under the gate of a Si MESFET at high applied drain field.

(*b*) Prove that for a MESFET operated under the two region model approach

$$L_1 = zL\,\frac{\left(u_c^2 - u_1^2\right) - 2/3\left(u_c^3 - u_1^3\right)}{1 - u_c}$$

where the symbols have their usual meanings.

(*c*) For a MESFET operated under velocity saturation model prove that

$$g_m = u_s Z \in_s / h$$

where the symbols have their usual meanings. 2 + 4 + 4

6. (*a*) For a silicon controlled rectifier prove that

$$I_A = \frac{ICo_1 + ICo_2 + \alpha_2 Ig}{1 - (\alpha_1 + \alpha_2)},$$

where the symbols have their usual meanings.

(*b*) Draw the Gummel-Poon model of a transistor. Indicate different circuit parameters. 6 + 4