M.Sc. 2nd Semester Examination, 2011

ELECTRONICS

(*Semiconductor Devices*)

PAPER—ELC-204

(Theory)

Full Marks : 40

Time : 2 hours

Answer **Q. No. 1** and any **three** questions 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 any *five* questions :   2 × 5

    (*a*) Derive the expression of pinch-off voltage of a MESFET.

(b) What do you mean by the neutral level of a metal semiconductor contact?

(c) Discuss qualitatively how can you measure the switching speed of a transistor?

(d) What is Schottky effect? How this effect influence the barrier height of a metal-semiconductor contact?

(e) Draw the equivalent circuit of a unijunction transistor. Define the intrinsic stand-off ratio of the device.

(f) Draw the physical structure of an integrated DIAC and sketch the I - V characteristics of the device.

2. (a) With a neat sketch, discuss different current components present in a *P-N-P* transistor. Define the terms base transport factor and emitter injection efficiency.

(b) For a *P-N-P* transistor derive the Ebers-Moll relation for I_E, I_C and I_B and from these current relation draw Ebers-Moll model.

$$(3 + 1 + 1) + (3 + 2)$$

3. (a) For a metal-semiconductor junction prove that $Eg = q \phi_{bn} + q \phi_{bp}$, where the symbols have their usual meaning.

(b) What is the image force induced lowering of potential energy for charge carrier emission of a Schottky diode ? Prove that

$$\Delta\phi = \sqrt{\frac{qE}{4\pi t_0}}$$

where symbols have their usual meaning. What do you mean by surface states pinning effect ?

$4 + (4 + 2)$

4. Draw the energy band diagram of an *n*-type Schottky barrier diode in the presence of interfacial layer and interface states. Derive an expression for the barrier height of the device. $2 + 8$

5. (a) Discuss the principle of operation of a unijunction transistor with proper diagrams. Draw the output characteristics of the device and explain it.

(b) Indicate different uses of an SCR. $(4 + 4) + 2$

(*Turn Over*)

6. (a) Define normally 'OFF' and normally 'ON' MESFET. Discuss qualitatively these MESFET with $\sqrt{I_D} - V_g$ Plot and define threshold voltage.

   (b) What do you mean by field dependent mobility ? Derive the expression of transconductance of a MESFET operated in the saturation velocity region.

   $(2 + 2 + 1) + (1 + 4)$