ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2008

MICROELECTRONICS & OPTOELECTRONIC DEVICES

SEMESTER – 4

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose correct answer from the given alternatives in each of the following questions : $10 \times 1 = 10$

i) When a transistor is used as switch its operation is confined to

a) cut-off region b) saturation region

c) active region d) both (a) & (b). ☐

ii) In a state of saturation a MOSFET acts as

a) a close switch b) an open switch

c) an amplifier d) an inductor. ☐

iii) In an *n*-channel MOSFET the condition for saturation is

a) $V_{GS} - V_{Th} \geq V_{DS}$ b) $V_{GS} - V_{Th} \leq V_{DS}$

c) $V_{GS} \leq 0$ d) $V_{Th} \leq 0$. ☐

iv) Fermi level of a heavily doped *n*-type semiconductor may lie in the

a) Valence band b) Conduction band

c) Middle of the Band gap. d) none of these. ☐

v) Solar cells operates in

a) 1st Quadrant of the I-V char.

b) 4th Quadrant of the I-V char.

c) 2nd Quadrant of the I-V char.

d) 3rd Quadrant of the I-V char. ☐

vi) Which of the following is quaternary material ?

a) Ge b) GaAs

c) InGaAlAs d) Si.

vii) Stimulated emission observed in

a) LED b) LASER

c) Solar cell d) Photodiode.

viii) Darlington pair behaves like a single transistor with a high current gain where current gain β is equal to

a) $\beta_1 \times \beta_2$ b) β_1 / β_2

c) $\beta_1 + \beta_2$ d) none of these.

ix) Which of the following detectors give amplified output ?

a) *p-n* photodiode b) *p-i-n* photodiode

c) Avalanche photodiode d) Photovoltaic detector.

x) MEMS actuators are devices which is capable to

a) convert mechanical strain into electrical o/p

b) convert electrical *i/p* into mechanical movement

c) convert both from mechanical *i/p* to electrical *o/p* and vice-versa

d) convert any form of input energy to mechanical energy.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. What is a heterojunction ? How many types of heterojunctions are possible ? Draw the band diagrams of each types of heterojunction. 1 + 1 + 3

3. What do you mean by a two-dimension electron gas ? What are the advantages of two dimension electron gas ? 3 + 2

4. Describe with suitable diagrams. The operation of a CCD. 5

5. With energy band diagram, describe Schottky junction barrier formation. Describe its operation under external bias. 3 + 2

6. Explain with block diagram, the punch through effect of a submicron MOS transistor. Explain the advantages of using an IGBT in place of a BJT. 3 + 2

GROUP – C

(Long Answer Type Questions)

Answer any *three* questions. 3 × 15 = 45

7. What do you mean by Thyristors ? Discuss the characteristic of Power MOSFETs. Sketch the cross-section of VMOS Power MOSFET structure and describe its operation. 2 + 3 + 10

8. What are Bulk micromachining and Surface micromachining ? Describe each with schematic diagrams. 5 + 10

9. Explain how we can design a high electron mobility system using heterojunction. What are the advantages of high electron mobility system ? What do you mean Ballistic transport ? 6 + 4 + 5

10. What do you mean by luminescence process ? How does a LED work ? Show the construction of typical LED. What are the applications of LED ? 3 + 5 + 5 + 2

11. Discuss the I-V characteristics of the MOSFET when biased in non-saturation and saturation regions.

To design the width of a MOSFET such that a specified current is induced for a given applied bias, consider an ideal *n*-channel MOSFET with parameters L = 1.25 μm, μ_n = 650 cm ^{2} / V-S, C_{ox} = 6.9 × 10 $^{-8}$ F/cm ^{2} and V_T = 0.65 V. Design the channel width W such that I_D (sat) = 4 mA for V_{GS} = 5V. 9 + 6

END