



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.TECH (ECE)/SEM-4/EC-405/2011**

**2011**

**Microelectronics and Optoelectronics Devices**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

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

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following :

10 × 1 = 10

- i) DIBL occurs in
  - a) short channel devices
  - b) long channel devices
  - c) both of these devices.
- ii) V groove is produced for
  - a) anisotropic etching
  - b) isotropic etching
  - c) both of these.



- iii) Schottky barrier diode can be used as
- a) low noise amplifier
  - b) variable capacitance
  - c) power supply rectifier
  - d) level detector.
- iv) In modern electronics millimeters, a FET or MOSFET is preferred over BJT because
- a)  $R_i$  is high
  - b)  $R_o$  is high
  - c)  $R_i$  is Low
  - d) it is cheaper.
- v) The energy gap of GaAs is
- a) 1.12 ev
  - b) 0.72 ev
  - c) 1.43 ev
  - d) 1.44 ev.
- vi) Vertical power BJT off resistance should be
- a) very low
  - b) very high
  - c) infinite
  - d) like intrinsic semiconductor.
- vii) Si Anisotropic etchant is
- a) HNA
  - b) KOH
  - c) HF
  - d) both (a) & (b).



- viii) The condition to form the heterojunction is
- that the bandgap of the semiconductor materials should be different.
  - that the work function should be different
  - both (a) and (b)
  - either (a) or (b).
- ix) Charge coupled devices are used to
- store the charge
  - transfer the charge
  - both (a) and (b)
  - none of these.
- x) In Schottky barrier diode, the current mechanism is due to
- majority carrier
  - minority carrier
  - both (a) and (b)
  - none of these.
- xi) The radiative and non-radiative life time of an LED are 2.5 ms and 60 ms respectively. The internal quantum efficiency is
- 96%
  - 24%
  - 100%
  - 104%.
- xii) Hall voltage is proportional to
- velocity
  - magnetic field
  - both a & b and parallel to the velocity
  - both a & b and perpendicular to the magnetic field.



- xiii) Most commonly used method for transduction in MEMS sensor is
- a) Piezo-electric effect
  - b) change of capacitance effect
  - c) magnetic effect
  - d) any of these.
- xiv) Photodetector used in optical fiber is
- a) p-i-n, APD
  - b) PIN, Gunn Diode
  - c) APD, Gunn Diode
  - d) none to these.
- xv) The radiative and non-radiative lifetime of an LED are 2.5 msec and 60 ms respectively. The internal quantum efficiency is
- a) 96%
  - b) 24%
  - c) 100%
  - d) 104%.

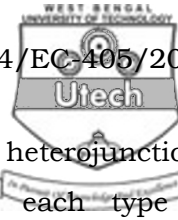
### GROUP – B

#### ( Short Answer Type Questions )

Answer any *three* of the following.

$$3 \times 5 = 15$$

2. Derive the one-dimensional continuity equation for minority carriers in generation recombination process under low injection condition.



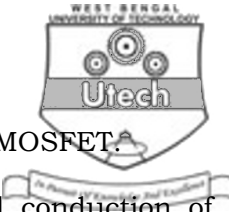
3. What is heterojunction ? How many types of heterojunctions are possible ? Draw band diagrams of each type of heterojunction ? 1 + 1 + 3
4. Sketch an npn darlington pair configuration and explain how the effective current gain can be increased by this configuration over that in power BJT. 2 + 3
5. Describe the operation of a CCD with suitable diagram.
6. a) What are population inversion in laser and external quantum efficiency in a semi-conductor laser ?  
b) What is the optical feedback and laser oscillation by which the amplified coherent emission is obtained ? (1 + 1) + 3

### GROUP – C

#### ( Long Answer Type Questions )

Answer any *three* of the following. 3 × 15 = 45

7. a) What is ambipolar transport ? Why carrier generation and recombination rate are same in thermal equilibrium ?  
b) Derive the one-dimensional continuity equation for minority carriers in generation recombination process, under low injection condition.  $G_n$ ,  $G_p$ ,  $R_n$  and  $R_p$  are generation and recombination rates for electron/hole.  
c) Describe the Einstein Equation and also prove it.  
d) What you mean by surface effect ? 5 + 4 + 3 + 3



8. a) Describe the short channel effect of a MOSFET.  
b) What do you mean by Subthreshold conduction of a MOSFET ?"  
c) Show the schematic structure and operation of typical LED. What are the applications of LED ?  
d) Discuss the principle of operation of vertical power BJT.

5 + 2 + 5 + 3

9. a) What is SCR ? Point out its major uses.  
b) By using two transistor analogies briefly describe the basic operation of two terminal SCR.  
c) Is it possible to observe the purpose of SCR by connecting two separate transistors ? Explain.  
d) How does the presence of third terminal controls the I-V response of SCR ? Explain with system diagram.  
e) Describe the different turn on & turn off mechanism of an SCR.

2 + 3 + 2 + 4 + 4

10. a) What do you mean by MEMS ?  
b) Explain one non-lithographic micro fabrication technology.  
c) Describe the Isotropic and Anisotropic etching. What do you mean by plasma etching ?  
d) Describe the Surface and Bulk Micromachining to design the pressure sensor.

1 + 3 + 5 + 6



11. Write short notes on any *three* of the following :  $3 \times 5$

- a) Rectifying Contact
  - b) Bulk micromachining in MEMS.
  - c) Surface emitting LED
  - d) Solar cells
  - e) MOSFET scaling
  - f) IGBT.
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