CS/B.TECH (ECE-N)/SEM-4/EC-405/09

1. .....
Signature of Invigilator

2. .....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | |

CS/B.TECH (ECE-N)/SEM-4/EC-405/09

ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

MICROELECTRONICS & OPTO-ELECTRONIC DEVICES (SEMESTER - 4)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

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Marks Obtained

	Group – A										Group – B			Group – C			*Total Marks*	*Examiner's Signature*
Question Number																		
Marks Obtained																		

.....
Head-Examiner/Co-Ordinator/Scrutineer

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SEMESTER - 4

Time : 3 Hours] [Full Marks : 70

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) Bilateral switch is

a) DIAC b) IGBT

c) Thyristor d) none of these. ☐

ii) The condition, where the majority carrier concentration is greater near the Si-SiO_2 interface compared to the bulk in the MOSFET is called

a) Accumulation b) Depletion

c) Inversion d) None of these. ☐

iii) Electron affinity depends on

a) semiconductor material b) doping of semiconductor

c) applied potential d) none of these. ☐

iv) The radiative and non-radiative life time of an LED are 2·5 ms and 60 ms respectively. The internal quantum efficiency is

a) 96% b) 24%

c) 100% d) 104%. ☐

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v) Photodetector is a

a) triangular device b) square low device

c) linear device d) both (a) and (b).

vi) Which of the following pairs are suitable for making a heterojunction ?

a) Si & Ge b) Si & GaAs

c) GaAs & AlAs d) GaAs & GaAlAs.

vii) Metal *n*-type semiconductor form ohomic contact if

a) $\phi_m > \phi_{sn}$ b) $\phi_m = \phi_{sn}$

c) $\phi_m < \phi_{sn}$ d) none of these.

viii) In charge transfer devices, charge can be transferred

a) in any direction b) in a predetermined direction

c) by diffusion process d) with the help of electric field.

ix) In *P-I-N* diode the I part refers to

a) extrinsic substrate b) intrinsic substrate

c) intrinsic semiconductor d) extrinsic semiconductor.

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.

xi) When BJT works as an amplifier its operation is confined to

a) Cut-off region b) Saturation region

c) Active region d) Both (a) and (b).

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xii) The equivalent circuit of an IGBT consists of

a) two bipolar transistors

b) two MOS transistors

c) one MOS transistor and one bipolar transistor

d) two bipolar transistors with one MOS transistor.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following questions. 3 × 5 = 15

2. a) What is SCR ? Point out its major uses.

b) By using two transistor analogy, briefly describe the basic operation of two terminal SCR.

3. What is the disadvantage of lateral DMOS structure ? Why VDMOS has higher packing density than LDOS ? 2 + 3

4. What is population inversion ? The population in two energy levels E_1 & E_2 are N_1 & N_2 respectively. Express the ratio N_1 / N_2 under normal condition assuming Boltzman statistics. $2\frac{1}{2} + 2\frac{1}{2}$

5. What is ambipolar transport ? Why carrier generation and recombination rate are same in thermal equilibrium ? 3 + 2

6. What is dynamic effects in MOS capacitors ? What are the applications of CCD ?

3 + 2

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GROUP – C

(Long Answer Type Questions)

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

7. a) What are the differences between Schottky junction diode and normal *p-n* junction diode ?

   b) With energy band diagram describe Schottky junction barrier formation. Describe its operation under external bias.

   c) What is semiconductor heterojunction ? Point out the classification of the same.

   d) A Schottky diode made from tungsten and *n*-type Si with doping $N_d = 10^{16}\ cm^{-3}$. If the work functions of the metal is 4·55 V and Si electron affinity is 4·01 V, calculate

      i) barrier height

      ii) built-in potential barrier

      iii) space charge with and

      iv) maximum electric field

      at the junction under zero applied bias at T = 300 K.

   2 + (2 + 3) + (2 + 2) + 4

8. a) What is MEMS ?

   b) What is micromachining technique ?

   c) Discuss in detail about different micromachining techniques.

   d) Discuss the photolithography process in connection with VLSI technology.

   1 + 1 + 9 + 4

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9. a) Distinguish between direct and indirect band-gap materials. Which one is useful for the design of optoelectronic devices and why ?

b) What are the advantages of LASER over LED ?

c) With diagram, explain briefly the operation of semiconductor laser.

d) An optical intensity of 10 W/cm^2 at $\lambda \sim 0{\cdot}75$ μm is allowed to incident on a GaAS based photodetector. Calculate the carrier generation rate at 300 K. For GaAs, $\alpha \sim 7 \times 10^3$ cm^{-1} and $E_g \sim 1{\cdot}43$ eV. (2 + 2) + 2 + (2 + 4) + 3

10. a) Explain the operation of CMOS as an inverter with circuit diagram.

b) How does CCD act practically in single phase and two phase arrangements ?

c) Describe the operation of insulated gate bipolar junction transistor (IGBT) with basic structure. 5 + (3 + 2) + 5

11. Write short note on any *three* of the following : 3 × 5

a) MEMS pressure sensor

b) OEIC

c) 2D electron gas

d) Solar cell

e) MOSFET scaling.

END

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