NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute)
Affiliated to Dr. A.P.J. Abdul Kalam Technical University, Uttar Pradesh, Lucknow
M.Tech
SEM: I - THEORY EXAMINATION (2021 - 2022)
Subject: MOS Device Modeling

Time: 03:00 Hours   Max. Marks: 70

General Instructions:

1. All questions are compulsory. It comprises of three Sections A, B and C.

- Section A - Question No- 1 is objective type question carrying 1 mark each & Question No- 2 is very short type questions carrying 2 marks each.
- Section B - Question No- 3 is Long answer type - I questions carrying 4 marks each.
- Section C - Question No- 4 to 8 are Long answer type - II questions carrying 7 marks each.
- No sheet should be left blank. Any written material after a Blank sheet will not be evaluated/checked.

SECTION A   15

1. Attempt all parts:-

1-a.   The saturation current is scaled by the factor of: _____ (CO1)   1
          1. 1
          2. $1/\alpha 2$
          3. $1/\beta$
          4. $1/\alpha$

1-b.   Increasing the transconductance _____ (CO2)   1
          1. increases input capacitance
          2. decreasing area occupied
          3. decreasing input capacitance
          4. decrease in output capacitance

1-c.   The interconnect capacitance is formed by _____(CO3)   1
          1. Gate diffusion capacitance
          2. Interconnect lines between the gates
          3. Inter electrode capacitance of interconnect lines
          4. None of the mentioned

1-d.   Top Silicon layer width in FDSOI is (CO4)   1
          1. 50- 90 nm
          2. 5- 20 nm
          3. 150-200 nm
          4. None of the above

1-e.   Which of the following is dominant component in input capacitance? (CO5)   1
          1. Gate diffusion capacitance
          2. Gate parasitic capacitance
          3. Gate oxide capacitance
          4. All of the mentioned

2. Attempt all parts:-

2-a.   What are the secondary effects of MOS transistor? (CO1)   2

2-b.	In a small signal equivalent model of an MOSFET, What does gm VGS stand for? Explain (CO2)	2
2-c.	What is the ideal sub threshold slope at room temperature? (CO3)	2
2-d.	Explain the term Fin in FinFET. (CO4)	2
2-e.	What is Cox? (CO5)	2

<div align="center">SECTION B   20</div>

3. Answer any <u>five</u> of the following:-

3-a.	Distinguish between conductors, insulators and semiconductors with energy band diagram. (CO1)	4
3-b.	Draw the small signal model of MOSFET amplifier at low frequency. (CO2)	4
3-c.	Draw and explain transfer characteristics of MOSFET. (CO3)	4
3-d.	Consider a MOSFET for which $L_{min} = 0.4$ μm, $t_{ox} = 8$ nm, $\mu n = 450$ cm^2/V· s, and $V_t = 0.7$ V. For a MOSFET with $W / L = 8$ μm $/ 0.8$ μm, calculate the values of V_{OV} and V_{GS} needed to operate the transistor in the saturation region with a DC current $I_D = 50$ μA. (CO4)	4
3-e.	Derive the formula for transconductance in MOSFET. (CO5)	4
3-f.	Explain the short channel effects in detail. (CO4)	4
3-g.	What is the physical expression for calculating the channel length in saturation mode? (CO2)	4

<div align="center">SECTION C   35</div>

4. Answer any <u>one</u> of the following:-

| 4-a. | Explain MOS capacitances and calculate various charges across MOSC. (CO1) | 7 |
| 4-b. | Sketch the energy band diagrams of an MOS capacitor with N-type silicon substrate and N+ poly-Si gate at flatband, in accumulation, in depletion, at threshold, and in inversion. (CO1) | 7 |

5. Answer any <u>one</u> of the following:-

| 5-a. | Describe the channel length modulation effect and define the parameter λ. Describe the body effect and define the gama parameter. (CO2) | 7 |
| 5-b. | Explain short channel and narrow width effect. (CO2) | 7 |

6. Answer any <u>one</u> of the following:-

| 6-a. | Explain and draw low-frequency small-signal equivalent circuit model of NMOS. (CO3) | 7 |
| 6-b. | Explain effect of source bias and body bias on device operation in details. (CO3) | 7 |

7. Answer any <u>one</u> of the following:-

| 7-a. | Compare and contrast the FDSOI and PDSOI devices. (CO4) | 7 |
| 7-b. | Explain in detail the various applications of Multigate SOI MOSFET. (CO4) | 7 |

8. Answer any <u>one</u> of the following:-

| 8-a. | Draw the variation of drain current in the weak inversion region, as the function of the gate voltage and for different values of the parameter NFS in level-2 model. (CO5) | 7 |
| 8-b. | Using the SPICE LEVEL 2 MOSFET model equations, derive an expression for the sensitivity of the drain current ID with respect to temperature. (CO5) | 7 |