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# PES University, Bengaluru

(Established under Karnataka Act No. 16 of 2013)

**UE18EC203**

## DECEMBER 2020: END SEMESTER ASSESSMENT (ESA), B.TECH
## CMOS Analog Circuit Design

Time: 3 Hrs | Answer All Questions | Max Marks: 100

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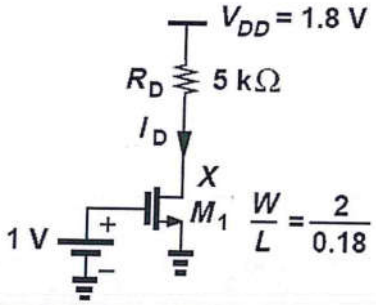
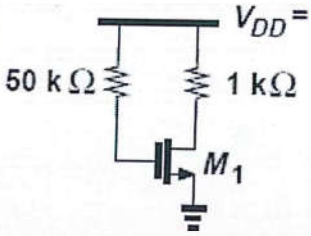
|---|---|---|---|
| 1 | a) | Derive an expression for the drain current of a n-channel MOSFET. | 7 |
| | b) | Calculate the bias current of $M_1$ in Fig. 1.b. Assume $\mu_n C_{ox} = 100\ \mu A/V^2$ and $V_{TH} = 0.4$ V. If the gate voltage increases by 10 mV, what is the change in the drain voltage?   | 6 |
| | c) | Based on the value of $V_{DS}$, write the large signal models of a n-channel MOSFET | 7 |
| 2 | a) | Derive an expression for the small signal gain of a common source amplifier with resistive load. | 7 |
| | b) | In the circuit of Fig. 2.b, determine the maximum allowable value of $W/L$ if $M_1$ must remain in saturation. Assume $\lambda = 0$. Assume $\mu_n C_{ox} = 200\ \mu A/V^2$ and $V_{TH} = 0.4$ V.   | 6 |
| | c) | Explain the large signal behavior of a common gate amplifier, hence obtain the transfer characteristics for the same. | 7 |
| 3 | a) | Explain the differential input-output characteristics of a MOSFET differential pair. | 7 |
| | b) | With neat circuit diagram obtain an expression for common mode gain of a differential pair sensing Common Mode input. | 6 |

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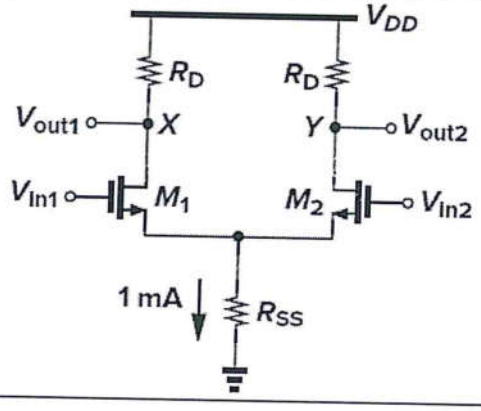
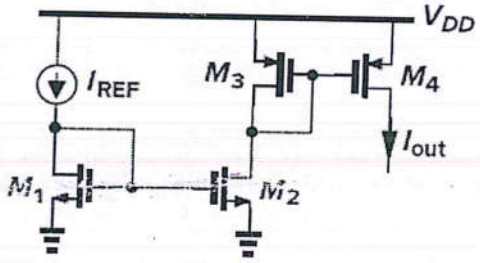
|---|---|---|---|
| | c) | The circuit of Fig. 3.c. uses a resistor rather than a current source to define a tail current of 1 mA. Assume that $(W/L)_{1,2} = 25/0.5$, $\mu nCox = 50\ \mu A/V^2$, $V_{TH} = 0.6$ V, $\lambda = \gamma = 0$, and $V_{DD} = 3$ V.<br>(a) What is the required input CM voltage for which $R_{ss}$ sustains 0.5 V?<br>(b) Calculate $R_D$ for a differential gain of 5.<br>  | 7 |
| 4 | a) | With neat circuit diagram explain about the voltage headroom consumed by the cascode current mirror circuit. | 7 |
| | b) | In Fig. 4.b, find the drain current of $M4$ if all of the transistors are in saturation.<br>  | 6 |
| | c) | Derive an expression for the short-circuit transconductance, $G_m$, and the output resistance, $R_{out}$ for the differential pair with current-source load. | 7 |
| 5 | a) | Get an expression for the transfer function of high-frequency model of a common-source stage, using Miller's approximation. | 7 |
| | b) | Explain how to determine the loop gain in a simple feedback circuit. | 6 |
| | c) | Show that the input impedance will be modified with feedback for a Common-gate circuit. | 7 |