MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL (A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION NOVEMBER 2023

SUBJECT: ANALOG AND MIXED SIGNAL DESIGN (ECE -4061), SET-1

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

Q. No.	Questions	M *	C*	A *	B
1A.	(a) Estimate the drain current for an NMOS transistor operating with $V_{GS} = 5 \text{ V}$ and $V_{DS} = 10 \text{ V}$ if $V_{TN} = 1 \text{ V}$, $K_n = 1 \text{ mA/V}^2$, and $\lambda = 0.02 \text{ V}^{-1}$. What is I _D for $\lambda = 0$? (b) Estimate the drain current and transconductance for an NMOS transistor operating with $V_{GS} = 2.5 \text{ V}$, $V_{TN} = 1 \text{ V}$, $V_{DS} = 0.28 \text{ V}$ and $K_n = 1 \text{ mA/V}^2$.	4	1	1	3
1B.	 (a) Sketch the drain current of M₁, shown in Figure 1B, versus V₁. V₁ varies from zero to VDD. Assume λ=0. V_{DD} Figure 1B. (b) Also, draw MOS signal models in saturation, triode and deep triode region, λ≠0. How the channel will be modeled in each region? 	3	1	1	3
1C.	Design for W/L of NMOS differential pair (Figure 1C) for a voltage gain of 5 and a power budget of 2 mW subject to the condition that the stage following the differential pair requires an input CM level of at least 1.6 V. Assume μ nCox = 100μ A/V ² , λ = 0, and VDD = 1.8 V.	3	2	1	4



		MOSFET parameters	0.18	μ m	-				
		Technology	NMOS	PMOS					
	_	μ C _{ox} (μΑ/V ²)	270	70					
		V _{t0} (V)	0.45	-0.45					
		$\lambda \cdot L$ (µm/V)	0.08	0.08					
		C_{ox} (fF/ μ m ²)	8.5	8.5					
		t _{ox} (nm)	5	5					
		n	1.6	1.7					
		θ (1/V)	1.7	1.0					
		m	1.6	2.4					
		$C_{ov}/W = L_{ov}C_{ox}$ (fF/µm)	0.35	0.35					
		$C_{db}/W \approx C_{ab}/W$ (fF/µm)	0.50	0.55					
	_	TABLE	2B.		•				
2C.	Figure 2C shows the Width W and its circ the current ratio erro	Figure 2	and W ₂ =	amplifier e identica 25±0.1.	with Length L and l (L ₁ =L ₂). Estimate	2	2	4	3
	A 11 / · · · ·				1 '				
3A.	All transistors in the 3A, are identical. Th If $I_{REF} = 250 \ \mu A$, det	MOSFET modified V to parameters are: V_{TN} termine I _{OUt} and V _{GS} f	Vilson cur = 1 V, β r for each tr	trent sources $n = 0.2 \text{ m/s}$ ansistor.	ce shown in Figure A/V^2 , and $\lambda = 0$.	4	2	4	3

	$H_{4} + H_{1} + H_{2}$ $H_{1} + H_{2} + H_{2}$ Figure 3A.				
	Consider a 5- transistor based OTA as shown in Figure 3B. Vdd=3V, Vt=0.3 V and all other values are marked				
3B.	(i) Estimate the Vout when Vin1=2 V and Vin2=0.1 V with operating condition of all transistors. (ii) What would be the relation between $I_D(M1)$, $I_D(M2)$ and Iss when Vin1=Vin2?	3	3	1	4
3C.	OTA.	3	3	1	3
4A.	 in a typical communication application, three sub-blocks are used to create complete flash ADC system as shown in Figure 4A. (i) Propose circuits of all sub-blocks considering the 3-bit Flash ADC system as an example. (ii) Estimate the binary output for Vin= 3.4V. 	5	4	2	5

	CIRCU RESISTO COMP/ Vref R=1	IT WITH ORS AND ARATOR. = 8V & k-ohm	ENCODER LOGIC		GRAY CODE OUTPUT					
			Figur	e 4A.						
	For a DAC, figure of merits like VFSR, DAC output, DAC resolution and full scale voltage are defined. Estimate the value of following missing parameters in the Table 4B. n=no.of bit, Vcc=power supply, FSV=Full scale voltage, V ₀ =DAC output, Input=input to DAC.									
4B.	n	<u>Vcc</u>	1LSB	V _{FSV}	Input	Vo	3	4	2	4
	2	?	?	?	10	?				
	3	?	?	?	111	?				
	4	?	?	?	1011	?				
	TABLE 4B.									
4C.	An 8-bit ADC is to digitize a five-volt, full-scale signal. What is the accuracy with which the ADC converter can digitize the following signals, 50 mV and 4.9 V?						2	4	2	3`
	Draw the CM	IOS layout of	the circuit she	own in Figur	e 5A					
5A.	Draw the CMOS layout of the circuit shown in Figure 5A. $V_{bp1} \circ - \int MP_1$ $V_{bp2} \circ - \int MP_2$ $V_{bn} \circ - \int MN_2$ $V_{in} \circ - \int MN_1$ <i>Figure 5A.</i>					4	5	2	3	
5B.	In a simple resistor string DAC, following Table 5B are given. 1LSB=0.11 V. (i) Estimate the missing parameters.					3	4	2	4	



M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level