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ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, NOV/DEC 2023

ELECTRONICS AND COMMUNICATION ENGINEERING
V Semester
EC5014 CMOS Analog IC Design
(Regulation 2019)

Time: 3hrs | Max.Marks: 100

CO 1	To carry out design of the various building blocks used in CMOS analog ICs. These include current mirror, cascades, common source amplifiers, differential amplifiers, two stage OTAs, source followers.
CO 2	To carry out the paper design based on hand calculations for the above important building blocks. This is normally the first mandatory step in the complete design and fabrication of CMOS Analog ICs, and enables the student to carry out circuit simulations and layout design. In conjunction with other similar courses in this area.
CO 3	To pursue design and/or research carriers in the broad field of electronics and communication.

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analysing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)
(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	For the circuit in Fig. 1, assume $(W/L)_2 = 2(W/L)_1$ and $(W/L)_4=2(W/L)_3$. Determine the raio of (I_4/I_{Ref})	2	CO1	L2
2	For Fig. 2, give the expression for the minimum voltage that can be obtained at the drain of M4.	2	CO2	L3
3	Consider the two possible open loop transfer functions given below and indicate which one is more preferable from stability point of view when used in a feedback amplifier configuration. Assume $f_{p1}<f_z<f_{p2}$ $A_{OL1} = (1+jf/f_z)/\{(1+jf/f_{p1})(1+jf/f_{p2})\}$ or $A_{OL2} = (1-jf/f_z)/\{(1+jf/f_{p1})(1+jf/f_{p2})\}$;	2	CO2	L3
4	Explain why Miller effect is not sufficient to fully explain the high frequency behavior of a common source amplifier.	2	CO1	L2
5	With the help of a suitable diagram of your choice, explain the principle of folded cascode amplifier.	2	CO2	L2
6	An open loop amplifier has low input impedance and high output impedance. Using this amplifier in negative feedback, it is required to reduce the closed loop input impedance further and also increase the output impedance. Explain what signal should be sensed at the output and what signal should be feedback as the input.	2	CO2	L3
7	In the equivalent circuit in Fig.3, identify the capacitors that are not due to reverse biased diodes.	2	CO1	L2
8	Explain how many poles and zeros are present in the amplifier whose gain magnitude is plotted as a function of frequency in Fig.4.	2	CO2	L3
9	For the circuit in Fig.5, in terms of threshold voltages and overdrive voltages of appropriate transistors, express the minimum common mode input voltage for Vn1 or Vn2. Assume all transistors need to be in saturation.	2	CO1	L2
10	Determine the small signal output impedance Vx/Ix for the circuit shown in Fig.6.	2		

PART- B (5 x 13 = 65 Marks)
(Restrict to a maximum of 2 subdivisions)

Q. No	Questions	Marks	CO	BL
11 (a) (i)	Sketch the cross section view of an NMOS transitor realized in p- type	3+3+3	CO1	L2

	substrate. Under pinchoff or saturation condition, indicate clearly the depletion regions near the source, near the drain and in the channel regions. Sketch the electric field under the gate near the source, near the drain and channel regions.			
(ii)	For the circuit in Fig.7, sketch Vout as a function of Vin as Vin varies from 0 to 3Volts. Assume Vth =0.5Volts.	4		
	OR			
11 (b) (i)	Derive the expressions for the output impedance and small signal gain of the source degenerated common source amplifier shown in Fig.8.	4+5	CO1	L2
(ii)	Sketch Vx as a function of time for the circuit shown in Fig.9. The initial voltage across C1 is 1V as indicated.	4		
12 (a) (i)	For the circuit in Fig.10 draw the symmetric half equivalent circuits for the small signal differential inputs. Similarly draw the symmetric half equivalent circuit for common mode inputs. Hence derive the expressions for the small signal differential gain (Vout1-Vout2)/(Vin1 –Vin2) and the small signal single ended common mode gains Vout/{(Vin1+Vin2)/2}. .	2+2 +2+ 2	CO1	L3
(ii)	Give the expression for the small differential gain of the circuit shown in Fig.11.	5		
	OR			
12 (b) (i)	Derive the expression for the small signal differential gain of the circuit shown in Fig.13	9	CO1	L3
(ii)	For the circuit shown in Fig.14, determine the relation between I_T and I_{REF}. Also determine the ratio $(W/L)_{M8}/(W/L)_{M5}$.	2+2		
13 (a)	Draw the high frequency equivalent circuit shown in Fig.15 and derive an expression for the transfer function and also the expressions for its poles and zeros.	3+4 +3+ 3	CO1	L4
	OR			
13 (b)	Draw the high frequency equivalent circuit for the circuit shown in Fig.16a. Derive expressions for its input and output impedances. Show that the output impedance can be represented by the network shown in Fig16b and determine the expressions of R1, R2 and L	3+3 +3+ 4	CO1	L4
14 (a) (i)	. Determine the expression for the total equivalent input mean square noise voltage spectral density for the circuit shown below Fig.17.	7	CO2	L2
(ii)	What are the units of the quantity kT/C and explain how it arises. Briefly state atleast one peculiar conclusion associated with it.	6		
	OR			
14 (b)	For the block diagram shown in Fig.18, determine the expressions for closed loop gain and output impedance.	8+7 / 7+6	CO2	L2
15 (a) (i)	Explain the terms gain and phase margins associated with feedback systems. Explain also the two terms peaking and overshoot. What is the phase margin for an amplifier that has only one pole in its open loop transfer function.	2+2 +1+ 1+2	CO2	L2
(ii)	An amplifier has an open loop gain given by $A_{DC}/(1+s/\omega_0)$. If this amplifier is used in a negative feedback loop with a feedback factor 'β', determine the expressions for the new 3dB cutoff frequency and also the Unity Gain Bandwidth UGB	5		
	OR			
15 (b)	In a two stage amplifier, explain how the dominant and non dominant poles get altered due to Miller compensation. With justification, explain whether any penalty is incurred due to Miller compensation. Explain any one procedure by which the zero in the transfer function can be made harmless.	5+3 +5	CO2	L2

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16. (i)	What could be approximate expression for the aspect ratio (ratio of Width to Length) of the equivalent transistor realized by the structure shown in Fig.19	5+5+5	CO2	L5
16 .(ii)	Determine the expression for the small signal low frequency differential gain (Vout1-Vout2)/Vin for the circuit in Fig.20			
16. (iii)	In the circuit of Fig.21, you have to first determine the short circuit output current for the given small signal input current I_{in}. Then determine the output impedance of the circuit, and finally determine the expression for the small signal gain (V_{out}/I_{in}).			

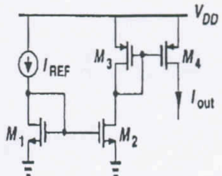

Fig.1

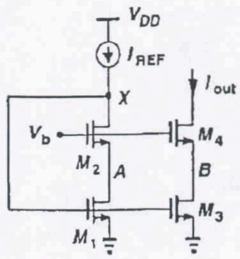

Fig.2

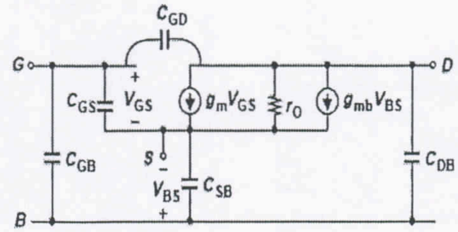

Fig.3

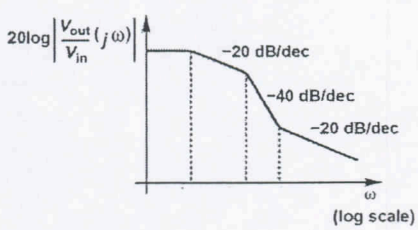

Fig4

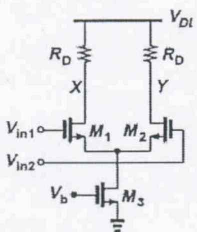

Fig.5

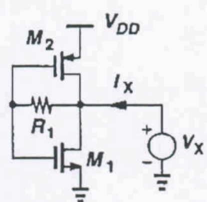

Fig.6

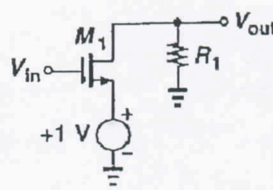

Fig.7

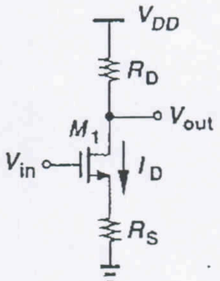

Fig.8

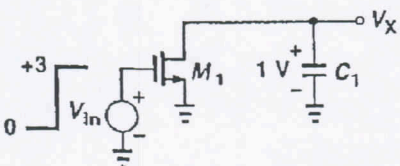

Fig.9

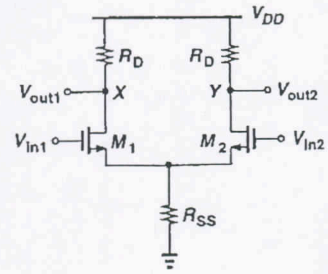

Fig.10

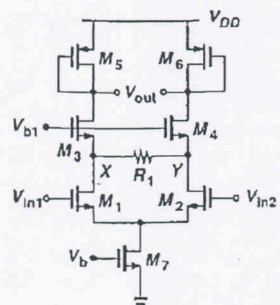

Fig.11

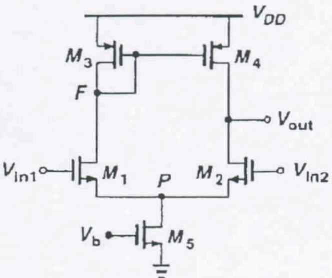

Fig.13

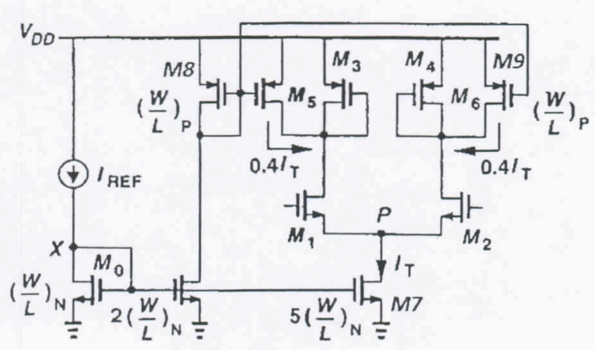

Fig.14

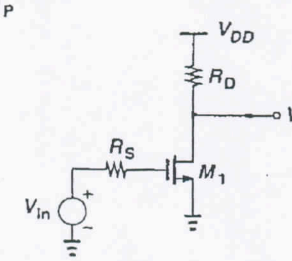

Fig.15

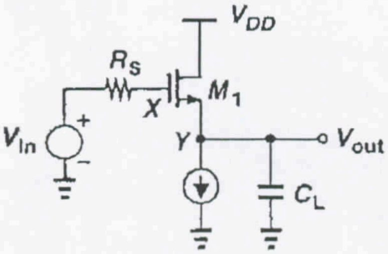

Fig.16a

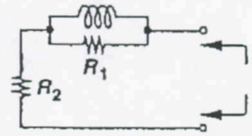

Fig.16b

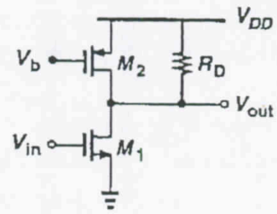

Fig.17

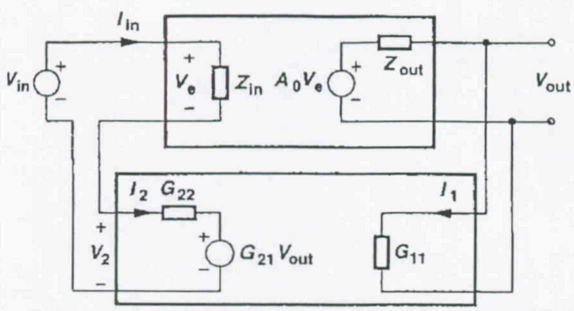

Fig.18

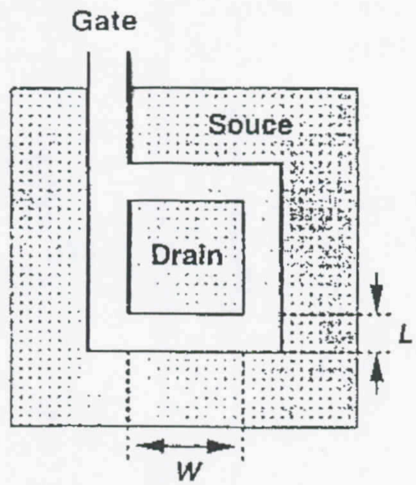

Fig.19

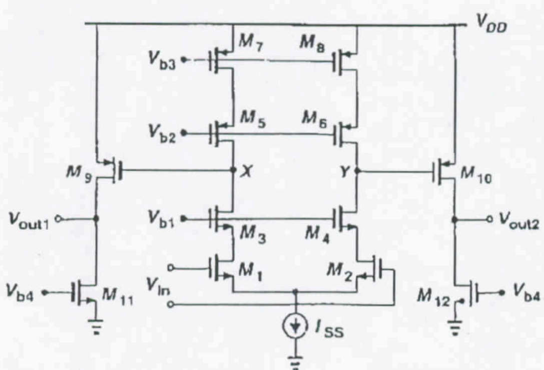

Fig.20

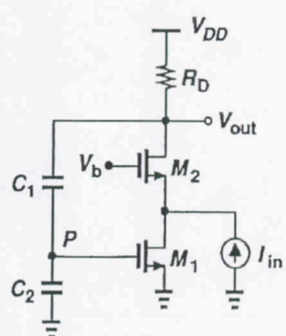

Fig.21