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M.Tech 1st Semester Examination. 2014 Session : **2014-15**

Discipline : AEIE

Paper Code : **AEIE5101** Paper Name : **MICRO-ELECTRONIC DEVICES AND CIRCUITS**

Time Allotted : 3 hrs Full Marks : 70

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.

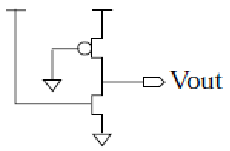
Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: 10 x 1=10

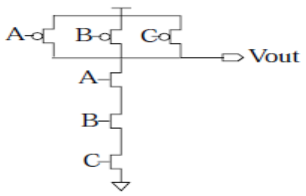
(i) The threshold voltage of an n-channel MOSFET can be increased by:
(a)Increasing the channel dopant concentration
(b) Reducing the channel dopant concentration
(c) Reducing gate oxide thickness
(d) Reducing the channel length

(ii) In the circuit below, what is V_{out} equal to?



(a) V_{DD} (b) 0V
(c) V_{DD}-V_t (d) Not enough information

(iii) The circuit given below



computes what function of A, B, and C?
(a) NAND (b) NOR
(c) AND (d) OR

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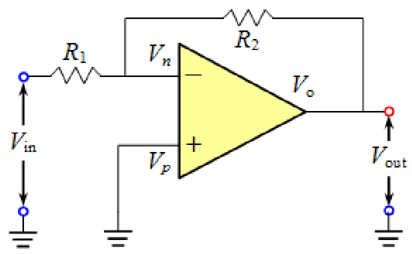
(iv) The extremely high input impedance of a MOSFET is primarily due to the
(a)absence of its channel
(b) negative gate-source voltage
(c) depletion of current carriers
(d) extremely small leakage current of its gate capacitor

(v) What is the difference voltage output from an OpAmp if the inputs are an ideal in phase signal?
(a)the differential gain times twice the input signal
(b) the differential gain times the input signal
(c) the common-mode gain times twice the input signal
(d) the common-mode gain times the input signal

(vi) An N-channel depletion mode MOSFET can be turned off by making VGS
(a) positive (b)zero
(c) negative (d)none of the above

(vii) MOSFET input resistance is typically of the order
(a)10^{10}-$10^{15}\Omega$ (b) 10^{10}-$10^{12}\Omega$
(c) 10^{10}-$10^{21}\Omega$ (d)none

(viii)



If R_1 = 10 kΩ, and R_2 = 30 kΩ, the input impedance of the circuit is
(a) 10kΩ (b) 40kΩ
(c) infinity (d) none of the above

(ix) Voltage follower is a special case of ___________.
a) inverting configuration
b) non-inverting configuration
c) difference configuration
d) integrator configuration

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(x) How does the average velocity of charge carriers vary with position along the channel of a modern MOSFET under large drain to source voltage?
a) The average velocity is constant from the source to the drain.
b) The average velocity increases from the source to the drain.
c) The average velocity decreases from the source to the drain.
d) The average velocity reaches a maximum between the source and the drain.

Group - B

2.(a) Explain with diagram the CMOS implementation of a clocked SR flip-flop using pass-transistor and compare it with a standard CMOS flip-flop realization.

(b) Describe the operation of a master-slave D flip-flop with the help of its circuit diagrams and two-phase non-overlapping clock wave forms. 5 + 7= 12

3.(a) Perform small signal analysis on a MOS cascade amplifier without the load circuit and derive an expression for voltage gain and output resistance.

(b) Design a MOS cascade amplifier current source to provide a current of 100μA and an output resistance of 500kΩ. Assume the availability of a 0.18μm CMOS technology for which V_{DD}= 1.8V, V_{tp}= -0.5V, $\mu_p C_{ox}$= 90μA/V^2 and V_A'= -5V/μm. Use $|V_{ov}|$= 0.3V and determine L and W/L for each transistor. 8 + 4= 12

Group - C

4 (a) Describe how to convert a monostable multivibrator to an astable multivibrator using suitable circuit diagram?

(b) For the circuit shown in Fig.1, let the op-amp saturation voltages be ±10V, R_1=100kΩ, R_2=R=1MΩ and C=0.01μF. Find the frequency of oscillation.

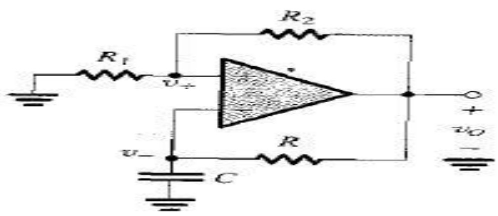

Fig.1

7 + 5= 12

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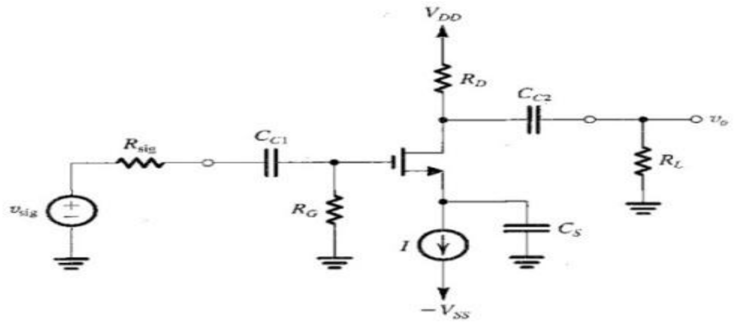
5.(a) Perform analysis on a single OpAmp difference amplifier and derive an expression for its common and differential mode gains. Also comment on its differential input resistance.

(b) It is required to connect a transducer having an open-circuit voltage of 1V and source resistance of 1MΩ to a load of 1kΩ resistance. Find the load voltage if the connection is done a) directly and b) through a unity gain voltage follower. 8 + 4= 12

Group - D

6.(a) Perform small signal analysis on the given NMOS amplifier circuit, shown in following figure. Find an expression for output impedance and voltage gain.



(b) Implement a switched capacitor filter circuit using OpAmp and derive an expression for its output resistance. 5 + 7= 12

7.(a) Explain the implementation of a monostable multivibrator using OpAmp and also derive an expression for time period of oscillation.

(b) Compare a bipolar current mirror with MOS mirror. What is bias compensation in a bipolar mirror and how does it improve current transfer ratio. 7 + 3+2= 12

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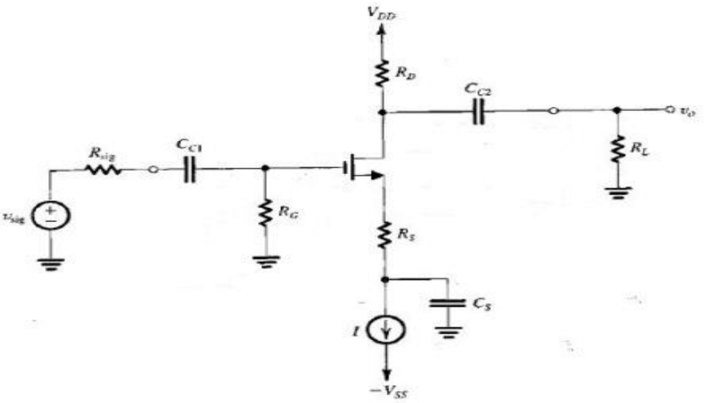
Group - E

8 (a) Perform small signal analysis on the common source amplifier, also find draw the equivalent circuit and deduce expressions for voltage gain, input and output impedances.



(b) Consider a CMOS inverter fabricated in a 0.18μm process for which V_{DD}=1.8V, $V_{tn}=|V_{tp}|$ = 0.5V, $\mu_n=4\mu_p$, and $\mu_nC_{ox}=300\mu A/V^2$. In addition, Q_N and Q_p have L=0.18μm and $(W/L)_n=1.5$.

i) Find W_p that results in $V_M=V_{DD}/2=0.9V$. What is the silicon area utilized by the inverter in this case.

ii) For the matched case above, find the values of V_{OH}, V_{OL}, V_{IH}, V_{IL} and noise margins NM_L and NM_H. For $V_i= V_{IL}$, find out the V_o.

iii) For the matched case above, find the values of output resistance for two inverter output states. 6 + 6= 12

9.(a) Implement the function $Y = \overline{AB+\overline{A}\ \overline{B}}$ using CMOS realization for OAI gates.

(b) Write short notes on any *two* of the following:

a) Widlar current source
b) Delay-Power product
c) Input bias and offset currents in an OpAmp
d) CMOS inverter circuit. 6 + (2x3) = 12