M.TECH/VLSI/3RD SEM/VLSI 6132/2020

RF IC DESIGN AND MEMS
(VLSI 6132)

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 × 1 = 10**

(i) Sensitivity can be defined as (consider a matched system)
(a) P_{sen}= -174dBm+NF+10logB+SNR_{min}
(b) P_{sen}= -174dBm+NF+10logB+SNR_{max}
(c) P_{sen}= -174dBm+NF+10logB_{max}+SNR_{max}
(d) P_{sen}= -174dBm+NF+10logB_{min}+SNR_{min}.

(ii) In RF design it is best to characterize LNAs by their
(a) Voltage gain (b) Current gain
(c) Trans-resistance gain (d) Power gain.

(iii) A two-pole system can oscillate only if
(a) Poles are located at the RHS plane (b) Poles are located at the LHS plane
(c) Poles are located at the origin (d) None of the above.

(iv) An amplifier senses a sinusoidal signal and delivers a power of 0 dBm to a load resistance of 50Ω. The peak-to-peak voltage swing across the load is
(a) 1264mV (b) 632mv (c) 1264μV (d) 632μV.

(v) The method of multiple access that employs" orthogonal messages" is known as
(a) TDMA (b) CDMA (c) FDMA (d) None of the above.

(vi) Piezoelectric effect is the production of electricity by
(a) Chemical effect (b) Varying field
(c) Temperature (d) Pressure.

(vii) The advantages of the Lab-On-a-Chip are
(a) Inexpensive (b) Fluid volume is very small
(c) Carry out DNA analysis (d) All of the above.

(viii) One of the following body functions is not monitored by the implantable sensors
(a) Glucose for diabetics (b) Temperature (c) Heartbeat (d) Pressure.

(ix) Schottky-defect in ceramic material is
(a) Interstitial impurity
(b) Vacancy- interstitial pair of cations
(c) Pair of nearby cation and anion vacancies
(d) Substitutional impurity.

(x) What term describes the maximum expected error associated with a measurement or a sensor?
(a) Resolution (b) Range (c) Precision (d) Accuracy.

Group – B

2. (a) Derive the expression of total noise figure of the cascaded stages. Mention the significance of Friis equation for the design of cascaded stages.

(b) Define noise figure. The receiver shown in *Fig. 1* incorporates a front-end band-pass filter to suppress some of the interferers that may desensitize the LNA. If the filter has a loss of L and the LNA has a noise figure of NF_{LNA}, calculate the overall noise figure.

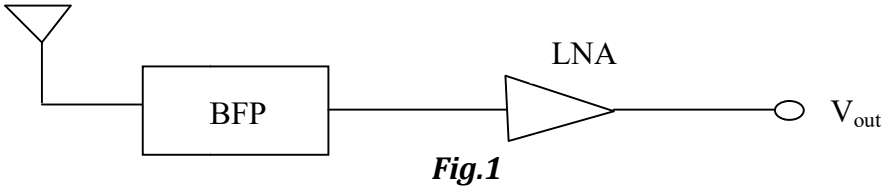

Fig.1

(6 + 2) + (1 + 3) = 12

3. (a) Can the flicker noise be modelled by a current source ? Mention the sources of noise in MOSFETs. Briefly explain the concept of Noise Figure. Explain why the output noise of a circuit depends on the output impedance of the preceding stage?

(b) Determine the noise figure of the circuit in *Fig.2* with respect to the source impedance R_S. Neglect channel length modulation and body effect.

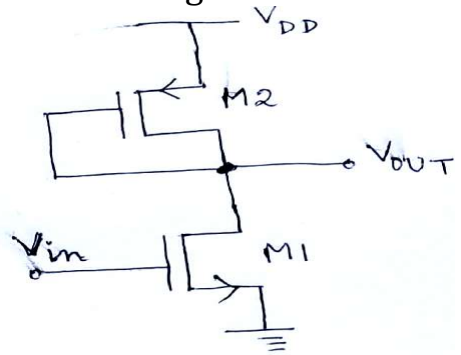

Fig.2

(2 + 3 + 2 + 2) + 3 = 12

Group – C

4. (a) Briefly discuss the Direct – Sequence CDMA technique. Compare CDMA with TDMA and FDMA.

(b) Briefly explain the operation of a double-balanced topology of active down-conversion mixer.

(5 + 3) + 4 = 12

5. (a) Derive the expression of $Re\{Z_{in}\}$ of a inductively loaded common-source stage LNA topology.

(b) For the inductively-loaded *CS* stage in *Fig. 3*, determine (V_{out} / V_{in}) and find the voltage gain at the resonance frequency,
$\omega_0 = (L_1 (C_1 + C_F))^{-1/2}$ *if* $|jC_1\omega_0| << g_m$.

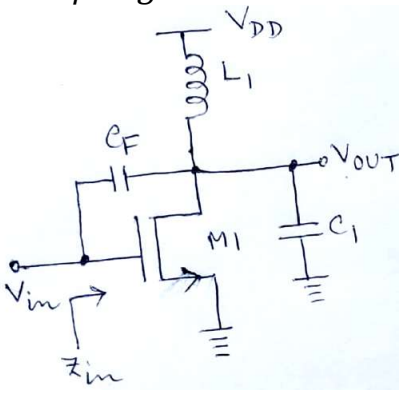

Fig.3

6 + 6 = 12

Group – D

6. (a) What are micromechanical resonators? What alterations can be made in the MEMS resonator to increase its resonant frequency?

(b) Explain the operation of a surface micromachined variable capacitor. What are the desirable properties in an RF micromechanical switch?

(3 + 2) + (5 + 2) = 12

7. (a) Write short notes on: (i) Isotropic etching, (ii) Dopant selective etching

(b) Illustrate the process of bulk micromachining in steps with the help of a proper diagram. What are the advantages of using Silicon Nitride as a substrate?

5 + (5 + 2) = 12

Group – E

8. (a) Explain the LIGA process with neat diagram. Mention the advantages and disadvantages of this process.

(b) Explain piezoelectricity and state how it is used in MEMS technology.

8 + 4 = 12

9. (a) Explain the working principle of a gas sensor. Find the Miller indices of a plane which has intercepts of (2,3,6) in the (a,b,c) crystallographic axes respectively.

(b) What are the different materials used in MEMS fabrication processes? Explain each one of their properties and application.

(5 + 2) + 5 = 12

Department & Section	Submission Link
VLSI	https://classroom.google.com/u/0/w/MjE1MDkxMDY0Njk5/tc/MjcyNzUxODU2MzY1