M.TECH/ECE (VLSI)/3RD SEM/VLSI 6101/2017

RF IC DESIGN AND MEMS TECHNOLOGY
(VLSI 6101)

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) In a RF receiver chain, the input noise of the mixer following the LNA is
(a) divided by the LNA gain
(b) multiplied by the LNA gain
(c) independent of the LNA gain
(d) none of the above.

(ii) MOS devices suffer from flicker noise which
(a) increases with increasing frequency
(b) decreases with increasing frequency
(c) independent of frequency
(d) None of these.

(iii) Increasing the oscillator signal-to-thermal noise ratio has what effect on the noise curve?
(a) The entire curve shifts up
(b) The entire curve shifts down
(c) Only the lower frequencies shift
(d) Only the upper frequencies shift.

(iv) A two pole system can oscillate only if
(a) poles are located at the origin.
(b) poles are located at the RHS plane.
(c) poles are located at the LHS plane.
(d) none of these.

(v) One of the applications of Bulk micromachining is
(a) SAW sensor (b) Resonant sensor
(c) Temperature sensor (d) Pressure sensor.

(vi) Cross talk is
(a) The disturbance caused in the nearby channel or circuit due to transmitted signal
(b) Adjacent frequency rejection
(c) Generation of closely lying side bands
(d) None of the above.

(vii) SOI stands for
(a) splitting of ions (b) silicon on insulator
(c) substrate on insulator (d) silicon orientation index.

(viii) Packages for bioMEMS should be
(a) inert to body temperature
(b) inert to biological attack of human systems
(c) inert to mishandling by user
(d) all of these.

(ix) The term LIGA refers to
(a) design (b) material
(c) microfabrication process (d) none of these.

(x) Anodic bonding of a silicon/gas substrate takes place under
(a) high temperature
(b) high pressure
(c) high temperature & pressure
(d) high temperature & high electric voltage.

Group - B

2. (a) What do you mean by an LC tank circuit? Define Q-factor for series RLC circuit.
(b) Determine the input refection coefficient and forwarding gain of a two port networks with S-parameters.
(c) What is skin effect and ground shielding?
(d) What are the different MOS capacitances arise due to high frequency effects?

3 + 3 + 4 + 2 = 12

3. (a) Explain sensitivity and dynamic range with respect to RF receiver.
   (b) A GSM receiver requires a minimum SNR of 12 dB and has a channel bandwidth of 200 KHz. A wireless LAN receiver on the other hand specifies a minimum SNR of 23 dB and has a channel bandwidth of 20 MHz. Compare the sensitivities of these two systems if both have an NF of 7 dB.

8 + 4 = 12

Group – C

4. (a) What are the main designing parameters for LNA in RF receivers?
   (b) Show that the noise of the mixer is divided by the gain from the input voltage source to the LNA output (assuming that the LNA and mixer are connected in cascade) for a RF receiver and determine the total noise figure.
   (c) What do you mean by stem stability factor and determine the stability condition.
   (d) A cascade stage exhibits a high reverse isolation, i.e., S_{12} is nearly equals to zero. If the output impedance is relatively high so that S_{22} is close to 1, then determine the stability conditions for LNA.

2 + 5 + 2 + 3 = 12

5. (a) Explain the operation of active and passive CMOS mixers.
   (b) Explain the working of charge pump PLLS.
   (c) Explain the effect of phase noise on VCO.

4 + 5 + 3 = 12

Group - D

6. (a) What are micromechanical resonators?
   (b) What alterations can be made in the MEMS resonator to increase its resonant frequency?
   (c) Explain the operation of a surface micromachined variable capacitor.
   (d) What are the desirable properties in an RF micromechanical switch?

3 + 2 + 5 + 2 = 12

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7. (a) Differentiate dry etching and wet etching in bulk micromachining.
   (b) What are the types of nonlithographic micro fabrication techniques? Explain any 2 process in detail.

6 + 6 = 12

Group - E

8. (a) Why is the electrostatic comb arrangement with many interdigited fingers used and where are they used?
   (b) Explain the working principle of a capacitor bulk accelerometer sensor.
   (c) Explain piezoelectricity and state how it is used in MEMS technology.

4 + 4 + 4 = 12

9. (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