Group – E

8. (a) Explain the LIGA process.

    (b) Draw a neat diagram of a MEMS accelerometer sensor and clearly explain its working principle.

    6 + 6 = 12

9. (a) Explain the working principle of a microelectromechanical resonator.

    (b) Distinguish between electrophoretic flow and electro-osmotic flow.

   (c) Write the fabrication steps of a square fluid nozzle. Draw a suitable diagram.

    3 + 4 + 5 = 12

RFIC 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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) For a RF Mixer conversion gain is having the unit of
    (a) Resistance   (b) Conductance
    (c) Voltage   (d) Current.

    (ii) For a good design of MOSFET, the relationship between the thermal noise arising from the gate resistance and the channel should satisfy
    (a) $4kT\dfrac{R_G}{3} << \dfrac{4kT\gamma}{g_m}$ (b) $4kT\dfrac{R_G}{3} >> \dfrac{4kT\gamma}{g_m}$
    (c) $4kT\dfrac{R_G}{3} = \dfrac{4kT\gamma}{g_m}$ (d) none of (a), (b) and (c).

    (iii) SFDR is the specification for
    (a) ADC   (b) DAC
    (c) all RFIC   (d) both ADC & DAC.

    (iv) If the line width of a spiral is doubled to reduce its resistance with Dout, S, and N remaining constant, the inductance
    (a) Reduces with reduction in mutual coupling
    (b) Reduces with decrease in diameter of the inner turns
    (c) both (a) & (b)
    (d) increases with increase in mutual coupling.

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

    (vi) In wet etching material is removed by
    (a) absorption   (b) sublimation
    (d) force exerted due to flow of solvent   (d) chemical reaction.

(vii) In the LIGA process the purpose of "develop" is to
(a) Strip the photoresist from the substrate surface after expose
(b) Remove the PMMA that has been exposed to radiation
(c) Remove the PMMA that has NOT been exposed to radiation
(d) Harden the PMMA that has been exposed to radiation.

(viii) 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.

(ix) 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 (a), (b) and (c).

(x) Which process is mostly used in Silicon micromachining?
(a) laser micromachining   (b) bulk micromachining
(c) micro-electro discharge machining   (d) powder blasting.

Group – B

2. (a) What do you understand by spectrum? Briefly discuss thermal and flicker noise in MOSFETs.

(b)
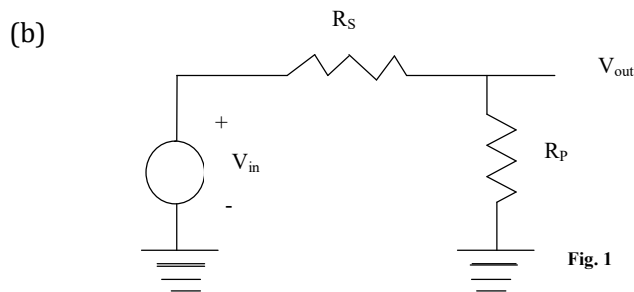
Fig. 1

Compute the noise figure of a shunt resistor R_P with respect to a source impedance R_S as shown in Fig. 1.

(3 + 6) + 3 = 12

3. (a) Briefly explain the phenomenon of cross modulation.

(b) Briefly discuss about gain compression. Define 1-dB compression point.

(c) An analog multiplier "mixes" its two inputs $x_1(t) = A_1 \cos \omega_1 t$ and $x_2(t) = A_2 \cos \omega_2 t$ and ideally produces $y(t) = kx_1(t)x_2(t)$, where k is a constant. If the mixer is ideal, determine the output frequency components. If the input port sensing $x_2(t)$ suffers from third-order nonlinearity, determine the output frequency components.

3 + (4 + 1) + 4 = 12

Group – C

4. (a) Explain the single-balanced and double-balanced topology of active down conversion mixers with proper circuit diagram.

(b) Explain the port-to-port feedthrough mechanism in a mixer.

(c) Distinguish between direct-sequence CDMA and frequency-hopping CDMA.

6 + 3 + 3 = 12

5. (a) Briefly discuss about the gain and stability parameters of the LNA.

(b) Compute the noise figure of a LNA topology having common-source stage with resistive feedback.

(c) A cascade stage exhibits a high reverse isolation $S_{12}=0$. If the output impedance is relatively high so that $S_{22}=0$, determine the stability condition.

4 + 6 + 2 = 12

Group – D

6. (a) Discuss the process of evaporation and sputtering with suitable illustrations.

(b) Discuss in detail how the CVD process can be utilized during the fabrication of Microsystems.

6 + 6= 12

7. (a) Differentiate between Microsensors and Microactuators with example.

(b) Briefly explain (i) Thermal actuation (ii) MEMS pressure sensor.

(c) What types of magnetic materials are used in MEMS?

4 + 6 + 2 = 12