

M.TECH/VLSI/3RD SEM/VLSI 6101/2018
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) Due to skin effect, the resistance of a trace will
(a) increase (b) decrease (c) remain unchanged (d) none of the above.
 - (ii) The principle noise arising in a MOSFET is due to
(a) flicker noise
(b) drain current noise
(c) gate noise
(d) shot noise.
 - (iii) In RF design, it is best to characterize LNAs by their
(a) current gain (b) voltage gain
(c) power gain (d) trans-resistance gain.
 - (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) 1264 μV (b) 1264 mV (c) 632 μV (d) 632 Mv.
 - (v) One of the applications of bulk micromachining is
(a) SAW sensor (b) resonant sensor
(c) temperature sensor (d) pressure sensor.
 - (vi) To design a mixer, which of the following characterizations is not preferred if noise figure is to be taken into account?
(a) Current gain (b) Power gain
(c) Voltage gain (d) Trans-resistance gain.
 - (vii) The advantage of the Lab-On-a-Chip is that
(a) it is inexpensive
(b) the fluid volume is very small
(c) it carries out DNA analysis
(d) all of the above.

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- (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) Anodic bonding of a silicon/gas substrate takes place under
(a) high temperature
(b) high pressure
(c) high temperature and pressure
(d) high temperature and high electric voltage.
- (x) Which 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) Highlight the difference between harmonic distortion and intermodulation.
(b) Define the third intercept point and explain why is it a key factor in the design of RF amplifiers?
(c) An LNA senses a -80dBm signal at 2.41 GHz and two -20dBm interferers at 2.42 GHz and 2.43 GHz. What IIP₃ is required if the IM products must remain 20 dB below the signal? Assume 50Ω interfaces at the input and output.
4 + 4 + 4 = 12
3. (a) Discuss a few techniques for designing matching networks in RF VLSI environment.
(b) Suppose we want to match a circuit whose input impedance is R_{in} = 250Ω to a load having R_L = 50Ω at an operational frequency of f = 2.45 GHz. Design an appropriate passive matching network to achieve the above situation. List any assumptions you make to arrive at your answer.
(c) Write a short note on passive capacitors and their design considerations.
4 + (4 + 1) + 3 = 12

Group – C

4. (a) Compute the noise figure of a common gate LNA. (Neglect the gate noise)
(b) What do you understand by the feedthrough mechanism in a mixer? Distinguish between single balanced mixers and double balanced mixers.
6 + 6 = 12
5. (a) With a neat diagram write the operating principle of a class- F amplifier.
(b) Write a short note on any one of the following
(i) GSM
(ii) CDMA
6 + 6 = 12

Group - D

- 6. (a) Distinguish between micromechanical structures, microsensor, microactuators with distinct examples of each type of structures.
- (b) What type of unit cell is exhibited by Si crystal?
- (c) Find the Miller indices of a plane which has intercepts of (3,5,6) in the (a,b,c) crystallographic axes respectively.
- (d) What is epitaxial growth of Si? Give proper chemical equation to illustrate the deposition process.

$$6 + 2 + 2 + 2 = 12$$

- 7. (a) Differentiate between dry etching and wet etching in bulk micromachining process.
- (b) Explain the method of sol-gel deposition and state its applications.

$$6 + 6 = 12$$

Group - E

- 8.(a) Distinguish between parallel plate and interdigitated comb capacitor with respect to configurations and basic working principle as a sensor when realized in MEMS technology.
- (b) Draw neat diagrams of a membrane switch in open and closed state. Also describe the working principle of such a switch in both the states.

$$6 + 6 = 12$$

- 9.(a) What is a pressure sensor?
- (b) Describe the working principle and structure of a piezoresistive pressure sensor.
- (c) Explain the working principle of a gas sensor.
- (d) Distinguish between electrophoretic flow and electroosmotic flow.

$$2 + 5 + 2 + 3 = 12$$