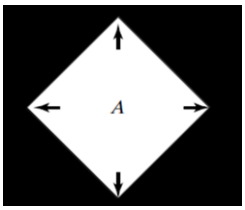
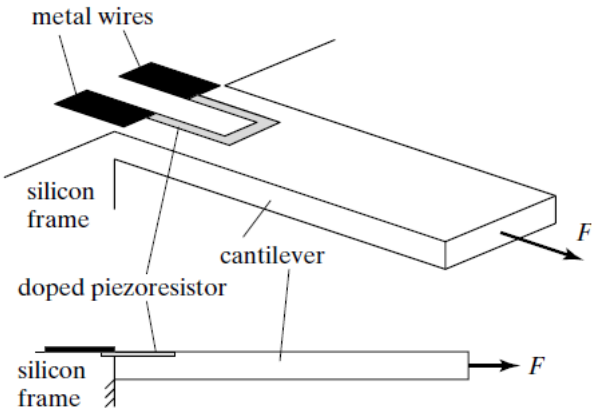
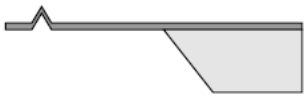
MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
MAY/JUNE 2024
SUBJECT: MEMS Technology (ECE 4306)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

Q. No.	Questions	M*	C*	A*	B*
1A.	In photolithography using positive photoresist, explain how the development stage transfers the mask pattern (Fig Q1A) onto the underlying substrate. Utilize a well-labeled diagram to illustrate the process.  Fig. Q1A	4	1	1	3
1B.	A square mask opening is used to create a cavity in a silicon wafer using anisotropic etching. Suppose the thickness of the wafer is t=500 µm and the window opening is 1 mm (w) on each side. The etch rate on <100> surface is r=2 µm/min (T). Ignoring the etch rate on surface <111>, calculate the size of opening on the back side of the wafer if etching time is longer than t/r<100>.	3	2	1	3
1C.	What would be the thickness of the wafer (Q 1B) if it were desired to form a blind cavity with an inverted point instead?	3	2	1	3
2A.	A phosphorous-doped silicon resistor is 100µm long 2 µm wide and 0.5 µm thick. The doping concentration is 10^{17} atoms/cm^3 The electron mobility (μ_n) which is a function of the doping concentration, is 1350 cm^2/(Vs). The hole mobility is approximately 480 cm^2/(Vs). What are the concentrations of electrons and holes under thermal equilibrium at room temperature? Find the resistivity of the material and the total resistance.	4	1	1	4
2B.	Explain the fabrication process of N Channel enhancement MOSFET.	3	1	1	2
2C.	A fixed-free cantilever is made of single crystal silicon. The longitudinal axis of the cantilever points in the [100] crystal orientation. The resistor(Fig. Q2C) is made by diffusion doping, with a longitudinal gauge factor of 50. The length *(l)*, width *(w)*, and thickness *(t)* of the cantilever are 200 µm, 20 µm and 5 µm, respectively. If a force F=100µN applied at the end of the cantilever in the longitudinal direction, what would be the percentage change of resistance?	3	3	1	3

	 Fig. Q2C				
3A.	A parallel capacitor with an area (A) of 100µm ×100µm is supported by four cantilever beams. The plate is made of polycrystalline silicon that is t = 2 µm thick. The distance between the bottom of the plate and the substrate is d=1 µm. Each cantilever beam is 100 µm long, 20 µm wide and 0.1 µm thick. Find the relative change of capacitance under an acceleration of 1 g.	4	3	1	3
3B.	Differentiate between isotropic and anisotropic etching of silicon with the help of neat diagram	3	3	1	2
3C.	List the important criterion for the substrate and material selection for the microheater	3	5	1	3
4A.	Explain the fabrication process of micro cantilever beam made of silicon nitride (Fig Q4A) on silicon substrate with the help of neat diagram  Fig. Q4A	4	2	1	3
4B.	Discuss the advantages and limitations of PDMS material for microfluidic chip.	3	4	1	2
4C.	Explain wafer bonding.	3	2	1	2
5A.	Explain the fabrication process of microfluidic with rectangular cross section using soft lithography.	4	4	1	3
5B.	Explain polymerase chain reaction (PCR). What are the challenges associated with stationary micro PCR chip?	3	5	1	2
5C.	Explain the challenges associated with the microfluidic mixers.	3	5	1	2

M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level