BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.Tech. + Pre-PhD **SEMESTER: SP-22**

BRANCH: ECE **SESSION: SP/22**

SUBJECT: EC576 Micro-Electro-Mechanical-Systems

TIME:02 Hrs **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a)	State the intrinsic characteristics of MEMS.	[2]
Q.1(b)	Construct an integrated accelerometer and state the operating principle.	[3]
Q.1(c)	Illustrate the processes for development of a silicon based micromachined pressure sensor with necessary flow diagrams.	[5]
Q.2(a)	Explain the thermal bimorph principle.	[2]
Q.2(b)	State the fundamentals of thermal transfer along with the governing equation of heat transfer rate for each possible mechanism.	[3]
Q.2(c)	Starting from the governing equation of a mass-spring-damper system, find out the response of a MEMS body under sinusoidal input. Comment on bandwidth and resonant frequency.	[5]
Q.3(a)	Design a MEMS actuator using piezoresistor.	[2]
Q.3(b)	Derive the expression for the pull-in-voltage of a parallel plate capacitor.	[3]
Q.3(c)	Describe mathematically piezoelectric effect with the help of schematic illustration of piezoelectric Crystal.	[5]
Q.4(a)	Explain tunnelling sensing.	[2]
Q.4(b)	Describe measurement of displacement in an accelerometer using optical Interferometry.	[3]
Q.4(c)	A fixed-free cantilever is made of single crystal silicon. The longitudinal axis of the cantilever points in the [100] crystal orientation. The resistor is made by diffusion doping, with a longitudinal gauge factor of 75. The length (l), width (w), and thickness (t) of the cantilever are 500 μm, 50 μm and 10 μm respectively. If a force $F = 150$ μN is applied at the end of the cantilever in the longitudinal direction, what would be the percentage change of resistance?	[5]
Q.5(a)	Compare and contrast various bonding techniques.	[2]
Q.5(b)	For <100> silicon crystal, define the relation between resistivity and stress expressed in a matrix equation format.	[3]
Q.5(c)	Describe integration options of micromechanical components with integrated circuits.	[5]

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