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

CLASS: M.Sc. SEMESTER: I **BRANCH: PHYSICS** SESSION: MO/2022 SUBJECT: EC547 FUNDAMENTALS OF MICRO-ELECTRO-MECHANICAL-SYSTEMS TIME: 03 Hours **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. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates ______ Q.1(a) State the intrinsic characteristics of MEMS. [2] Draw a diagram illustrating the structure and operating principle of an integrated pressure sensor. [3] Q.1(c) Tabulate brief description of major process categories under microfabrication. [5] Q.2(a) Analyse flexural beam bending, starting from types of beams with various boundary conditions, [2] longitudinal strain under pure bending and deflection of beams. Q.2(b) Find out the spring constant of a fixed-free cantilever beam. [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 damping factor and quality factor Q.3(a) State the fundamentals of thermal transfer along with the governing equation of heat transfer rate [2] for each possible mechanism. Q.3(b) Explain the thermal bimorph principle Q.3(c) Describe mathematically piezoelectric effect with the help of schematic illustration of piezoelectric [5] crystal in a rectangular system. Illustrate a model of cantilever piezoelectric actuator. Q.4(a) Discuss wafer bonding. [2] Q.4(b) Compare and contrast various bonding techniques along with respective bonding materials and [3] remarks. Q.4(c) Describe each of the options for integrating micromechanical components with integrated circuits [5]

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[2]

[3]

[5]

with the help of a schematic diagram. Discuss the pros and cons of these options.

Q.5(c) Illustrate design principles and commercial implementation of a MEMS accelerometer.

Review the background / history of microphone.

Q.5(b) Detail design considerations of a MEMS blood pressure sensor.