Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

Course:	**Micro and Nano Robotics**	**Semester:**	**VIII**
Program:	**B. Tech (Mechatronics Engineering)**	**Time:**	**03 hrs**
Course Code:	MECH4043	**Max. Marks:**	**100**

Instructions:
1. Carefully read all the questions before attempting.
2. Assume any missing data and clearly state your assumptions.
3. Provide detailed explanations and show all necessary calculations.
4. Use appropriate units and notation where required.
5. Diagrams and sketches should be neat and labelled properly.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Define micro/nanorobots and describe their potential applications.	**4**	**CO1**
Q 2	Explain what happens to a quartz crystal when mechanical stress is applied.	**4**	**CO1**
Q 3	Describe stack-type piezoelectric actuators and discuss their significance.	**4**	**CO2**
Q 4	What happens to a quartz crystal when mechanical stress is applied?	**4**	**CO2**
Q 5	List two benefits of electrostatic actuators.	**4**	**CO1**
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	In a biological imaging scenario, select and demonstrate which type of microscopy (bright-field, fluorescence, or confocal) would best meet the requirement for cellular-level detail, and justify your choice based on its key features.	**10**	**CO3**
Q 7	Compare the force output of thermal actuators with that of electrostatic actuators.	**10**	**CO3**
Q 8	Create a sketch of a setup using the Michelson interferometer to measure nanoscale displacement in a flexible biomedical microrobot. Then, identify one key integration challenge and propose a practical way to overcome it.	**10**	**CO2**

Q 9	Apply the concept of the Hamaker constant to compare Van der Waals attraction forces between two different microrobot materials in a fluidic environment. Use your understanding to predict which material pair might lead to stiction issues. OR Use the dynamics and scaling principles to determine how a microcantilever's resonance frequency changes as its size is reduced. Then, interpret how this affects its mechanical behaviour in sensing applications.	**10**	**CO4**
SECTION-C (2Qx20M=40 Marks)			
Q 10	Analyze the complete working mechanism of Scanning Electron Microscopy (SEM) by breaking down how the electron source, vacuum system, and detectors interact to produce high-resolution surface images. Compare the role of each component and evaluate how they collectively contribute to image quality.	**20**	**CO4**
Q 11	Design a microrobot to deliver drugs. Explain the key factors to consider when choosing materials for the robot. Focus on Van der Waals forces, biocompatibility, and the specific environment where the robot will be used. **OR** Derive an expression for the force between a sphere and a plane due to Van der Waals interactions. Explain the assumptions made during the derivation. How would you modify this expression to account for surface roughness?	**20**	**CO4**