# Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | L | T | P | Total |
| EXL803 | MEMS Technology Laboratory | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | ISE | | ESE | | | | Total |
| | | | | Practical | | Oral | | |
| | | 40 | | -- | | 20 | | 60 |

| Pre-requisite Course Codes | | EXC803 (MEMS Technology) |
|---|---|---|
| After successful completion of the course, student will be able to | | |
| Course Outcomes | CO1 | Design and simulate MEMS devices and system using Industry graded simulation tools like COMSOL and Coventorware. |
| | CO2 | Determine characteristics of given MEMS device using Hardware setup. |
| | CO3 | Design and simulate MEMS devices and system using open source simulation tools like sugar. |
| | CO4 | Relate the given literature with the studied concepts of MEMS. |

| Exp. No. | Experiment Details | Ref. | Marks |
|---|---|---|---|
| 1 | **Aim:** To analyze MEMS cantilever in Matlab.<br>**Problem Statement:** For the given MEMS cantilever with given dimensions and uniformly distributed load a) To plot the variation in stiffness constant (K) for varying length (L) keeping its width (W), thickness (h) constant and different values of effective length (λr=L/Lc) of uniformly distributed load.<br>b) To plot the variation in stiffness constant (K) for varying width (W) keeping its length (L), thickness (h) constant and different values of effective length (λr=L/Lc) of uniformly distributed load.<br>c) To plot the variation in stiffness constant (K) for varying thickness (h) keeping its width (W), length (L) constant and different values of effective length (λr=L/Lc) of uniformly distributed load | 1,2,4 | **05** |
| 2 | **Aim:** To model MEMS cantilever in COMSOL Multiphysics.<br>**Problem Statement:** For the given dimensions and material create MEMS cantilever model in COMSOL and observe the dependence of resonance frequency of the cantilever on material. | 1,2,4 | **05** |

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| **3** | **Aim:** To analyze MEMS cantilever in COMSOL Multiphysics.<br>**Problem Statement:** For the cantilever model analyze dependence of fundamental resonance frequency on varying length (given range), plot the result and also compare the result with analytical expression of resonance frequency. | 1,2,4 | **05** |
| **4** | **Aim:** To analyze MEMS Piezoelectric Harvester model.<br>**Problem Statement:** Choose the proper configuration, dimensions and the method of conversion (converter) for obtaining dc voltage from ac voltage generated by the MEMS Piezoelectric Harvester. Obtain the output voltage graph for any two different substrates materials against Silicon as a substrate material. | 1,2,3 | **05** |
| **5** | **Aim:** To analyze MEMS cantilever in Sugar Tool.<br>**Problem Statement:** Choose the proper dimensions of MEMS cantilever modeled in Sugar. Choose the proper co-ordinate and node for applied point contact force. Observe and tabulate the maximum displacement of the cantilever for at least three different values of point contact load, verify one of the readings with given analytical expression of maximum displacement of the cantilever. | 1,2,3 | **05** |
| **6** | **Aim:** To model and analyze Piezoresitive Pressure Sensor in MEMS Design and Simulation FEM Tool (CoventorWare).<br>**Problem Statement:**<br>a) Choose the proper substrate; define the process flow and Layout of Piezoresitive pressure sensor in MEMS Design and Simulation FEM Tool (CoventorWare) and create a its 3 D Layout.<br>b) Observe the change in resistance of piezoresistance for given input pressure. Compare this reading with the given analytical expression of the change in resistance of the piezoresistace. | 1,2,4 | **05** |
| **7** | **Aim:** To evaluate the performance of the fabricated MEMS micro-heater.<br>**Problem Statement:** For the given fabricated MEMS micro-heater, | 1,2,4 | **05** |

| | | | |
|---|---|---|---|
| | a) To measure the temperature of the heated membrane for the input excitation voltage and compare it with the given analytical expression.<br>b) To plot the temperature response of heated membrane to standard test voltages like square, Ramp, and sinusoidal. | | |
| **8** | **Aim:** To model and analyze the Hot Arm actuator in COMSOL Multiphysiscs.<br>**Problem Statement:** For the given model of Hot Arm actuator in COMSOL Multiphysiscs,<br>a) Describe the complete process flow, schematic representation of the mask layout and draw the final structure.<br>c) Observe the spatial variation of electric potential, temperature of the Hot Arm actuator before and after the deflection of the Hot Arm actuator.<br>b) Observe and draw the effect of change in width of flexures on the deflection of the Hot Arm actuator. | 1,2,4 | **05** |
| | | **Total Marks** | **40** |

**References:**


[1] Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing

[2] Microsystem Design - by S. Senturia; Publisher: Springer

[3] www.nanohub.org

[4] MEMS Technology Laboratory Manual