Unit 8 - Week 6

Assignment 6

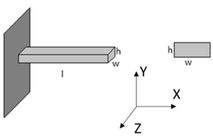
The due date for submitting this assignment has passed. **Due on 2020-03-25, 23:59 IST.**
As per our records you have not submitted this assignment.

1) Consider a cantilever beam of length l, width b, and depth h made of a material with Young's modulus Y. It has a fundamental natural frequency f_1. ***2 points***
After scaling the width to αb and depth to βh, its natural frequency changes to f_2. Calculate the ratio of these frequencies ($f1 : f2$), if values of α and β are 10^{-3} and 10^{-4} respectively. You can use, frequency, $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ where, k is stiffness and m is effective mass of the beam. Again, $m = cm_b$, where, c is a constant and m_b is actual mass of the beam. You can also consider only transverse vibration

- 10^{-1}
- 10^{-2}
- 10^{4}
- 10^{3}

No, the answer is incorrect.
Score: 0
Accepted Answers:
10^4

2) **Consider a beam made of polysilicon with Y= 170 GPa as shown in figure having length 100 µm, width 10 µm and height 15 µm. A proof mass of 50 µg is attached to its free end resulting in guided beam kind of motion. An acceleration is applied i) in Y-direction 12 m/s^2 and ii) in Z-direction (i.e., perpendicular to the side face of the beam) 15 m/s^2. If the spring constant for a guided beam is $\frac{12YI}{l^3}$, what will be the magnitude of the deflection produced in Y and Z direction, respectively? All symbols have usual meaning.** ***2 points***



- i) 0.29 µm, ii) 0.10 µm
- i) 0.10 nm, ii) 0.29 nm
- i) 0.10 µm, ii) 0.10 µm
- i) 0.10 µm, ii) 0.23 µm
- i) 0.29 µm, ii) 0.29 µm
- i) 0.15 nm, ii) 0.23 nm

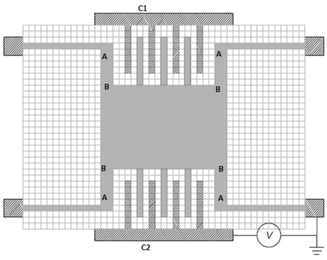
No, the answer is incorrect.
Score: 0
Accepted Answers:
i) 0.10 nm, ii) 0.29 nm

3) 3. The electric energy density of a parallel plate capacitor (plate area A, gap between the plates d), if the electric field inside is E, is ***1 point***

- $\frac{1}{2}\epsilon_0 E$
- $\frac{1}{2}\epsilon_0 E^2$
- $\frac{1}{4}\epsilon_0 E^2$
- $\frac{1}{2}\epsilon_0 E^3$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{1}{2}\epsilon_0 E^2$

4) **The schematic of an in-plane accelerometer with a crab-leg suspension is shown below. Assume it is made of silicon whose Young's modulus is 169 GPa. The thickness everywhere is 25 µm. Each square in grid has a size 5 µm × 5 µm. In order to perform a self-test, how much voltage needs to be applied to get a displacement of 5 nm? (Deflection of beams AB is negligible and the top fixed comp C1 is not connected to circuit)**



Voltage = _____ V

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 500,580

4 points

5) Which of the following processes will not avoid stiction? ***1 point***

- Fabricating a stiff cantilever
- Using wider beam instead of narrow beam
- Using methanol for washing instead of water
- Making narrow dimples at the tip of cantilever
- Super-critical drying

No, the answer is incorrect.
Score: 0
Accepted Answers:
Using wider beam instead of narrow beam

6) Thickness of a <100> silicon wafer is 410 µm. A square window of 1000 µm size is opened in the oxide on the front surface of the wafer with the mask edge aligned parallel to the <110> direction. The oxide on the back of the wafer is completely etched. This wafer is subjected to anisotropic etchant whose etch rate along the <100> direction is 50 µm/hour. Due to this etching process for duration 4 hours, a square diaphragm of thickness t µm and side x µm has been created. Determine the diaphragm thickness t in _____ µm

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) 10

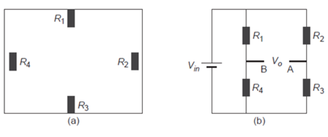
2 points

7) With the data given in question number 6, determine diaphragm side x in _____ µm

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 700,730

2 points

8) **Polycrystalline p-type piezo-resistors R1, R2, R3, and R4, each of them equal to R = 1kΩ, are arranged as shown in figure below on oxide grown on a single-crystal membrane having lateral dimensions 1mm × 1mm and thickness =10 µm. The polysilicon resistor has longitudinal gauge factor G_L = 30 and the transverse gauge factor G_T is negligibly small (G_T = 0). These resistors are connected in the form of a Wheatstone bridge as shown below. Assuming v = 0 and Y = 150 GPa for polysilicon, in this pressure sensor, what will be the sensitivity (in mV/Bar) for an input voltage of V_{in} = 10 V?**



_____ mV/Bar

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 490,510

4 points

9) The maximum stress a Si pressure sensor can withstand is 7 GPa. Pressure is applied on a square membrane of side 2a = 500 µm and thickness h = 10 µm. What should be the maximum operating range (in bar) of this pressure sensor for a safe application?

_____bar

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 20,25

2 points