

Unit 6 - Week 4

Course outline

How does an NPTEL online course work?

Week 0

Week 1

Week 2

Week 3

Week 4

Pressure Sensor - I

Pressure Sensor - II

Pressure Sensor - III

Accelerometer - I

Accelerometer - II

Quiz : Assignment 4

A brief introduction of Micro-Sensors: Week 4 Feedback form

Week 4 Lecture Materials

Assignment 4 solutions

Week 5

Week 6

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Assignment 4

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment.

Due on 2020-02-26, 23:59 IST.

1) Pressure sensor measuring pressure relative to vacuum is

1 point

- Differential pressure sensor
 Absolute pressure sensor
 Gauge pressure sensor
 Both absolute and gauge pressure sensor

No, the answer is incorrect. Score: 0

Accepted Answers: Absolute pressure sensor

2) I need to calculate pressure without any input voltage. Which of the following materials could be used as a sensing element in the pressure sensor?

1 point

- Piezo resistive
 Piezo electric
 Capacitive
 None of the above

No, the answer is incorrect. Score: 0

Accepted Answers: Piezo electric

3) Which of the following is most preferred as the sensing element in a piezoresistive sensors?

1 point

- Metal foils
 Thin metal films
 Diffused semiconductor
 Polycrystalline silicon

No, the answer is incorrect. Score: 0

Accepted Answers: Diffused semiconductor

4) For a square membrane of side $2a$ and thickness h , choose the correct relation, where σ is the stress due to pressure P .

1 point

- $\sigma_{max} = P_{max} \left(\frac{a}{h}\right)^3$

 $\sigma_{max} = P_{max} \left(\frac{a}{h}\right)^2$

 $\sigma_{max} = P_{max} \left(\frac{h}{a}\right)^3$

 $P_{max} = \sigma_{max} \left(\frac{a}{h}\right)^2$

No, the answer is incorrect. Score: 0

Accepted Answers: $\sigma_{max} = P_{max} \left(\frac{a}{h}\right)^2$

5) Mark the correct order in fabricating a piezo resistive pressure sensor :

2 points

- 1) Implanting boron for the piezo resistors.
- 2) Connecting the resistors to form a Wheatstone bridge.
- 3) Anisotropic etching of silicon to obtain the membrane.
- 4) Bond bottom wafer to obtain the pressure port.

- 1-2-3-4
 2-1-3-4
 3-1-2-4
 3-2-1-4

No, the answer is incorrect. Score: 0

Accepted Answers: 3-1-2-4

6) Find the applied pressure (in Pa) so that the membrane made of silicon with young's modulus 170GPa, side $2a = 500 \mu\text{m}$ and thickness $h = 10 \mu\text{m}$ made a deflection of 2 nm. _____ Pa

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 380,410

2 points

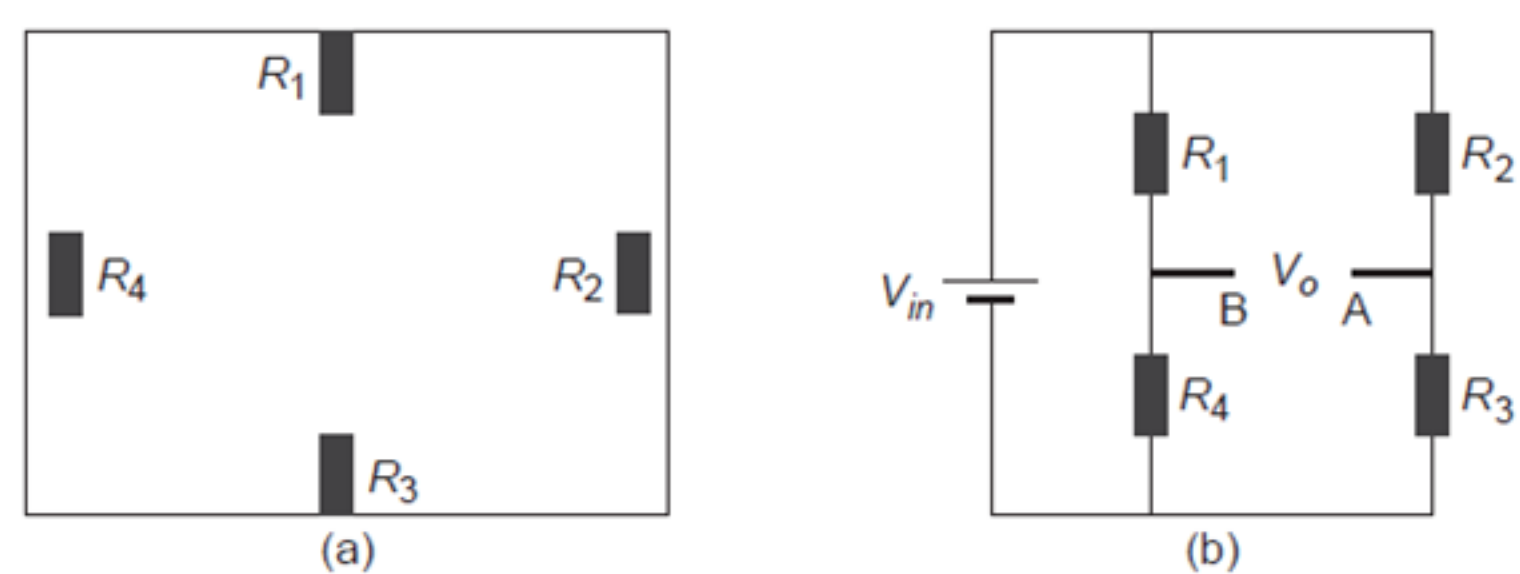
7) What will be the burst pressure (in bar) for the membrane mentioned in question 6 if maximum strength of silicon is 7 GPa? _____

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 100,125

3 points

8) Polycrystalline p-type piezo-resistors $R_1, R_2, R_3,$ and R_4 , each of them equal to $R = 1\text{k}\Omega$, are arranged as shown in figure below on oxide grown on a single-crystal membrane having lateral dimensions $1\text{mm} \times 1\text{mm}$ and thickness $= 10 \mu\text{m}$. The polysilicon resistor has longitudinal gauge factor $= 30$ and the transverse gauge factor is negligibly small ($= 0$). These resistors are connected in the form of a Wheatstone bridge as shown below. Assuming $\nu = 0$ and $Y = 150 \text{ GPa}$ for polysilicon, in this pressure sensor, what will be the sensitivity (in mV/Bar) for an input voltage of 10 V?



_____ mV/Bar

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 490,510

4 points

9) Find the natural frequency (in KHz) of an accelerometer having a proof mass of 0.2 mg (lumped mass) and an effective spring constant of 400 N/m. _____ KHz

No, the answer is incorrect. Score: 0

Accepted Answers: (Type: Range) 6.5,7.6

2 points

10) The maximum stress a Si pressure sensor can withstand is 7 GPa. Pressure is applied on a square membrane of side $2a = 500 \mu\text{m}$ and thickness $h = 10 \mu\text{m}$. 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

3 points