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[NPTEL \(https://swayam.gov.in/explorer?ncCode=NPTEL\)](https://swayam.gov.in/explorer?ncCode=NPTEL) » [A brief introduction of Micro-Sensors \(course\)](#)
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Unit 4 - Week 2

Course outline

How does an NPTEL online course work?

Week 0

Week 1

Week 2

- Electrostatics (unit? unit=27&lesson=30)
- Electrostatic force (unit? unit=27&lesson=31)
- Coupled electromechanics (unit? unit=27&lesson=32)
- Stiction (unit? unit=27&lesson=33)
- Week 2 Lecture materials (unit? unit=27&lesson=52)
- Quiz : Assignment 2 (assessment? name=48)**

Assignment 2

The due date for submitting this assignment has passed. **Due on 2020-02-12, 23:59 IST.**
As per our records you have not submitted this assignment.

1) 1. Four particles, each with charge q , are placed at corners of a square. Another charge Q of **2 points** opposite sign is placed at centre of the square such that the total force on each four particles is zero. Which of the following relation is correct regarding charges Q and q ?

- $q=0.96Q$
- $Q=0.96q$
- $q=0.76Q$
- $Q=0.76q$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$Q=0.96q$

2) Consider a spherical charge distribution which has constant charge density ρ from $r = 0$ to $r = a$ and is zero beyond. Choose the correct pattern of electric field from the following for r less than 'a' and for r greater than 'a' respectively **2 points**

- $\frac{1}{4\pi\epsilon_0} \frac{\rho}{r^2}$, $\frac{1}{4\pi\epsilon_0} \frac{\rho}{a^2}$
- $\frac{1}{\epsilon_0} \frac{\rho}{r}$, $\frac{1}{4\pi\epsilon_0} \frac{\rho}{a}$
- $\frac{4}{\epsilon_0} \frac{\rho}{3r^2}$, $\frac{4}{\epsilon_0} \frac{\rho}{3a^2}$

A brief introduction of Micro-Sensors: Week 2 Feedback form (unit? unit=27&lesson=50)

Assignment 2 - Solution (unit? unit=27&lesson=59)

Week 3

Week 4

Week 5

Week 6

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$$\frac{\rho r}{3\epsilon_0}, \frac{a^3}{3\epsilon_0} \frac{\rho}{r^2}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{\rho r}{3\epsilon_0}, \frac{a^3}{3\epsilon_0} \frac{\rho}{r^2}$$

3) The capacitance of two concentric metal shells, with radii a and b (where, a < b) is

2 points

$$C = 4\pi\epsilon_0 \frac{ab}{b-a}$$

$$C = 4\pi\epsilon_0 \frac{ab}{b+a}$$

$$C = 4\pi\epsilon_0 \frac{a^2b^2}{b^2-a^2}$$

$$C = 4\pi\epsilon_0 \frac{a^2b^2}{b^2+a^2}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$C = 4\pi\epsilon_0 \frac{ab}{b-a}$$

4) If the plates of a parallel plate capacitor move closer together by a distance 'Δ', what will be the magnitude work done in terms of the field 'E' and area of the plates 'A'. **1 point**

$$\frac{\epsilon_0 E^2 A^2 \Delta^2}{2}$$

$$\frac{\epsilon_0 E^2 A \Delta}{2}$$

$$\frac{\epsilon_0 E^2 \Delta^4}{2A}$$

$$\frac{\epsilon_0 E^2 A}{2 \Delta}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{\epsilon_0 E^2 A \Delta}{2}$$

5) Choose the correct option in case of parallel plate capacitor with overlapping distance of 'x': **1 point**

i. $F_N = \frac{bx\epsilon_0\epsilon_r V^2}{2d^2}$, $F_T = \frac{b\epsilon_0\epsilon_r V^2}{2d}$ where F_N and F_T are the normal and transverse forces respectively.

ii. If $x \gg d$, $F_T \gg F_N$.

- a. Only I is correct
 b. Only ii is correct
 c. Both I and ii are correct
 None of the above is correct

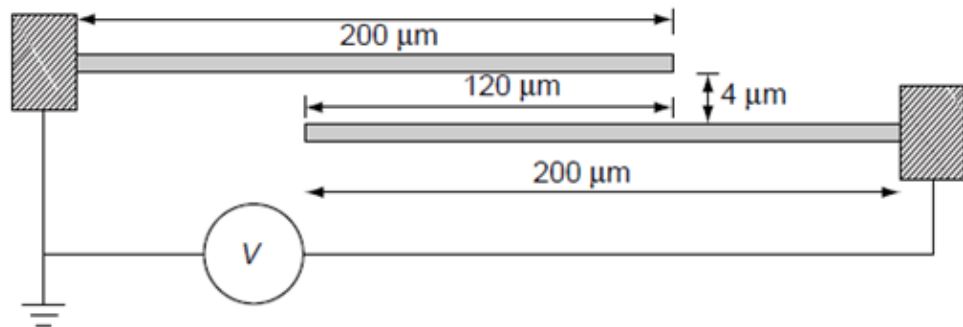
No, the answer is incorrect.

Score: 0

Accepted Answers:

a. Only I is correct

6) Figure below shows two polysilicon beams of length $200\ \mu\text{m}$, width $2\ \mu\text{m}$ and out of plane thickness $10\ \mu\text{m}$ separated by an in-plane gap of $4\ \mu\text{m}$. The beams overlap, as shown in the figure, over a length of $120\ \mu\text{m}$. Assume that the Young's modulus is $155\ \text{GPa}$. What is the pull-in voltage for this pair of beams



Voltage = _____ Volts

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 17,20

5 points

7) 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

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

No, the answer is incorrect.

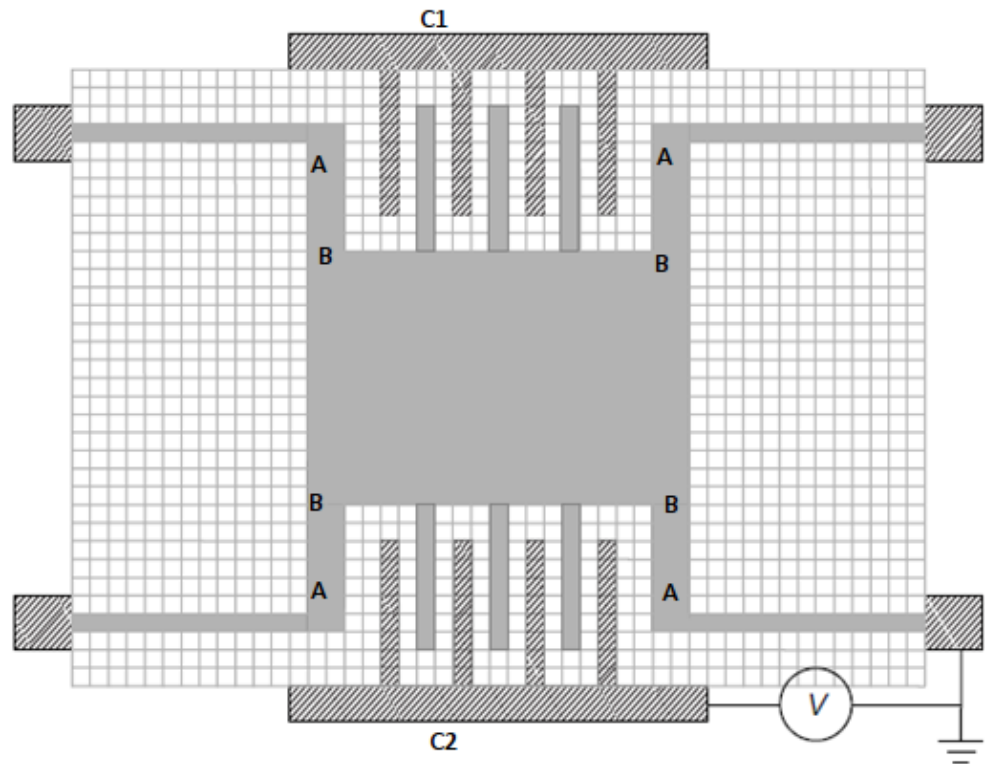
Score: 0

Accepted Answers:

$\frac{1}{2}\epsilon_0 E^2$

8) 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 $169\ \text{GPa}$. The thickness everywhere is $25\ \mu\text{m}$. Each square in grid has a size $5\ \mu\text{m} \times 5\ \mu\text{m}$. 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

9) 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

10) Which of the following should not be used for either sublimation or super-critical drying?

1 point

- Liquid CO_2
- P-dichlorobenzene
- Liquid t-butylalcohol

DI water

No, the answer is incorrect.

Score: 0

Accepted Answers:

DI water