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Announcements

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## Unit 8 - Week 7

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### Week-7 Assignment on Piezoelectric transducer

1)

5 points

A piezoelectric transducer with a sensitivity of  $3.0 \text{ pC/N}$ , having a capacitance of  $1800 \text{ pF}$  and a leakage resistance of  $10^{11} \Omega$ , is connected to a charge amplifier as shown in Figure 1. If a force of  $0.1 \times \sin(10t) \text{ N}$  is applied to the transducer, what is the output amplitude of the charge amplifier.

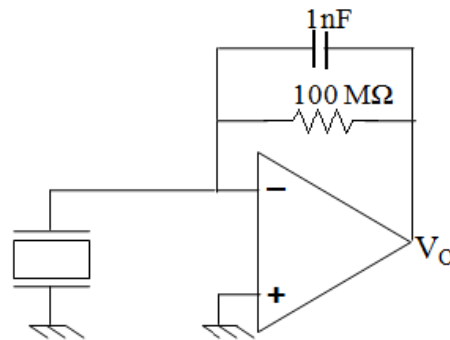


Figure 1

- a) 0.212 V
- b) 0.212 mV
- c) 2.12 mV
- d) 21.2 mV

**Accepted Answers:**

b) 0.212 mV

2)

2 points

A piezoelectric type accelerometer has a sensitivity of  $150 \text{ mV/g}$ . The accelerometer subjected to a constant acceleration of  $10 \text{ g}$ . What will be the steady-state output of the transducer?

- a) 1.5 V
- b) 150 mV
- c) 0
- d) None of these

**Accepted Answers:**

c) 0

3)

4 points

A piezoelectric transducer, having capacitance of 1 nF and leakage resistance  $10^{12} \Omega$ , connected to a parallel load  $Z_L$ .  $Z_L$  comprises of a 1 M $\Omega$  resistance ( $R_L$ ) and a 0.5 nF capacitor ( $C_L$ ), in parallel. What will be the approximate value of load voltage  $V_L$  at very high frequency for unit amplitude of charge?

(Hint: Find the expression for  $V_L$  in Laplace domain with-respect-to charge. Then observe from this expression what approximation can be made if  $\omega$  is very high)

- a) 0
- b) 0.667 V
- c) 0.333 V
- d) 1 V

**Accepted Answers:**

b) 0.667 V

4)

2 points

A piezoelectric crystal has the following specifications: voltage sensitivity ( $g$ ) = 30  $\mu\text{V}/\text{m}\cdot\text{l}$  Relative permittivity of the piezoelectric material ( $\epsilon_r$ ) = 2.5. Young's modulus of elasticity ( $E$ ) = 10  $\text{MN}/\text{m}^2$ . If equivalent voltage across the crystal is 10 mV, then calculate capacitance of the crystal for an applied force of 100 N. (Vacuum permittivity =  $8.85 \times 10^{-12} \text{ F}/\text{m}$ )

- a) 4.71 pF
- b) 5.52 pF
- c) 6.64 pF
- d) 7.76 pF

**Accepted Answers:**

c) 6.64 pF

5)

2 points

Five piezoelectric crystals are combined, as shown below, to form a multimorph. Capacitance each crystal is 2 nF. What is the net capacitance ( $C_{eq}$ ) of the multimorph, between the terminals A and B in figure 2?

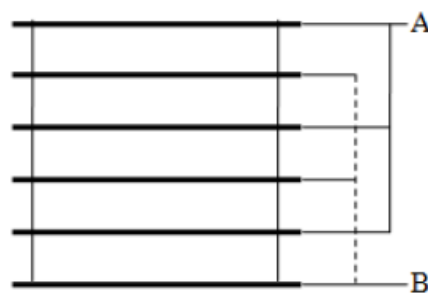


Figure 2

- a) 0.4 nF
- b) 2.5 nF
- c) 8 nF
- d) 10 nF

**Accepted Answers:**

d) 10 nF

6)

5 points

A synthetic piezoelectric transducer, having capacitance 100 pF and leakage resistance  $10^{12}$   $\Omega$  used to measure pressure. The transducer has the following specifications:

Dimension: 6 mm  $\times$  5 mm  $\times$  3 mm; Relative permittivity ( $\epsilon_r$ ) = 2.0; Young's modulus of elasticity ( $E$ ) = 100 GPa, voltage sensitivity ( $g$ ) = 12 mV/m-Pa, total capacitance due to connecting cable and amplifier is 2.5 nF and amplifier input impedance is 1 M $\Omega$ . Find the amplitude of the system transfer function (excitation frequency 100 Hz). (Vacuum permittivity =  $8.85 \times 10^{-12}$  F/m)

- a) 2.1 nano
- b) 2.9 nano
- c) 21 nano
- d) 29 nano

**Accepted Answers:**

a) 2.1 nano

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