Quiz #3 (see also overleaf)

20 questions single choice (only one answer is correct)

Name:

Sciper:

1. In a cochlear implant electrode array, which of the following statements is correct?

☐ Low frequencies are stimulated near the base, and high frequencies near the apex of the cochlea.
☐ Low frequencies are stimulated near the apex, and high frequencies near the base of the cochlea.
☐ Stimulation intensity is lower near the base and higher near the apex of the cochlea.
☐ Stimulation intensity is higher near the base and lower near the apex of the cochlea.

2. A capacitive microphone includes the following elements

☐ A linear response with lower sensitivity.
☐ A nonlinear response with lower sensitivity.
☐ Higher sensitivity and a linear response.
☐ Higher sensitivity but at the expense of linearity.

3. How does a capacitive microphone transform sound into an electrical signal?

☐ Sound waves alter the resistance of the diaphragm.
☐ Sound vibrations change plate separation, varying capacitance and generating an electrical signal.
☐ Sound pressure generates voltage through piezoelectric crystals.
☐ None of the above

4. What is the primary advantage of using a dual (differential) capacitor configuration in an accelerometer?

☐ It significantly reduces the physical size of the sensor.
☐ It linearizes the output by compensating for the non-linear behavior of a single-capacitor sensor.
☐ It eliminates the effect of gravity on the measurement.
☐ It doubles the sensitivity without any negative trade-offs.

5. What is the primary advantage of using closed-loop modulation in a capacitive accelerometer?

☐ Higher mechanical stiffness
☐ Sensitivity independent of mechanical stiffness
☐ Sensitivity independent of temperature changes
☐ Sensitivity independent of the accelerometer's mass

6. Which approach is commonly used to estimate jump height with a wearable accelerometer?

☐ Differentiate acceleration to obtain velocity and displacement.
☐ Integrate acceleration twice (first to velocity, then to displacement) and analyze the free-fall time interval.
☐ Integrate acceleration once and calculate the square root of the result.
☐ Use the peak acceleration value measured during the jump directly.

7. How is the Coriolis force used in gyroscopes best described?

☐ A magnetic force caused by the Earth's rotation.
☐ An inertial force observed in rotating reference frames, causing deflection of moving objects.
☐ A frictional force within the gyroscope's mechanism
☐ A gravitational force acting on moving masses.

8. Which sensor placement location enables a single 3-axis accelerometer to effectively distinguish between human standing and sitting (on a normal chair)?

☐ Chest
☐ Thigh
☐ Shank
☐ Wrist

9. In the gait cycle, the first negative peak in shank angular velocity occurring after the positive peak associated with mid-swing corresponds to which gait event?

☐ Heel-off
☐ Toe-off
☐ Foot-flat
☐ Initial contact (heel strike)

10. Why does a pneumotachometer typically include a fine mesh screen or laminar flow element in its design?

☐ To intentionally induce turbulence for an enhanced pressure signal.
☐ To humidify and warm the airflow.
☐ To limit airflow exceeding a specific threshold.
☐ To maintain laminar (smooth) airflow, ensuring a stable, proportional pressure drop related directly to the flow rate.

11. Which type of pneumotachometer element ensures a linear relationship between pressure drop and airflow rate, given the specified Reynolds number (Re)?

☐ Venturi tube
☐ Tubular screen (Re < 2000)
☐ Grid (Re > 2000)
☐ Open tube

12. In spirometry, how is the volume of inhaled or exhaled air determined using measurements from a pneumotachometer?

☐ By measuring and subtracting pressures at two different points.
☐ By differentiating the volumetric flow rate Q over time
☐ By integrating the volumetric flow rate Q over time—this means summing small increments of flow multiplied by their respective time intervals (since Volume = Flow × Time).
☐ Volume cannot be determined directly; only airflow can be measured.

13. Why is an electrical "poling" process necessary for piezoelectric materials (e.g., ceramics, PVDF)?

☐ To improve the thermal stability of the material
☐ To align electric dipoles, enabling piezoelectric behavior
☐ To increase the mechanical toughness of the material
☐ To reduce electrical conductivity of the material

14. A piezo ceramic with metalized surface A measures electrical quantities in direction 3 when a force (F) is applied in direction 3. When the two faces of a piezo ceramic is circuited, then:

☐ the generated voltage is equal to d33·F/ε
☐ the generated charge is equal to d33· F
☐ the generated charge is equal to d33 · F ·A
☐ the generated voltage is 0

15. A piezoelectric material (d33≠d31, relative permittivity εr and small thickness e) is configured to measure shear forces (direction 1), with charges collected on electrodes placed perpendicular to direction 3. When combined with an amplifier, the sensitivity of the measurement system:

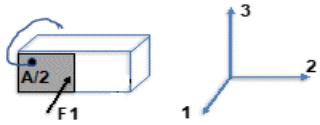
☐ increases inversely with εr, when using charge amplifier
☐ increases inversely with εr, when using voltage amplifier
☐ increases proportionally with d33
☐ is maximum at DC (0Hz)

16. For a piezoelectric sensor with metallized surfaces, what is the difference between charge density and total generated charge?

☐ Charge density is the total charge divided by the surface area; total (collected) charge is the product of charge density and the electrode (metalized) area.
☐ Charge density and total charge are equivalent quantities and always equal in value.
☐ Charge density depends only on the applied force, while total charge depends solely on the piezoelectric coefficient.
☐ Total charge is measured in volts, while charge density is measured in coulombs.

17. A force F1 is applied in direction 1 on the face 1 of a piezo ceramic (piezoelectric coefficients: d11) where only half of the surface (A/2) is metalized.
The collected (total) quantity of charge is equal to:

☐ 2d11·F1
☐ (d11·F1)/2
☐ (d11·F1·A)/2
☐ d11·F1



18. You want to measure force with a piezoelectric sensor and not be dependent on sensor permittivity. What conditioning circuit(s) will you use?

☐ Wheatstone bridge
☐ Charge amplifier
☐ Voltage amplifier
☐ Differential amplifier

19. What is the primary purpose of using a charge amplifier with a piezoelectric sensor?

☐ To convert the sensor's generated charge into a measurable voltage, while maintaining the sensor's terminals at nearly zero voltage (measuring charge directly).
☐ To amplify the voltage output of the sensor using a high-impedance buffer.
☐ To enable the piezoelectric sensor to measure static (DC) displacements
☐ To intentionally introduce additional capacitance for enhanced stability.

20. Which of the following factors can introduce errors or noise into measurements obtained from piezoelectric sensors?

☐ Temperature fluctuations causing pyroelectric effects
☐ Mechanical movements of cables causing triboelectric effects
☐ Moisture or condensation causing short-circuits between electrodes
☐ All of the above