VIT
Vellore Institute of Technology

Continuous Assessment Test-2

Program Name & Branch: B. Tech-ECE(IoT)

Course Name & Code : ECE2023 Principles of Sensors and Data Acquisition

Class Number: VL2019201003647 **Slot:** B1/TB1 **Exam Duration:** 1½ Hrs. **Max. Marks:** 50

Answer all Questions

1. A differential amplifier with input-output terminals X, Y, Z is connected as shown in Fig. 1.a. It measures the output voltage as $V_o = 3mV$ when the input voltage $V_i = 2V$, and $V_o = 4mV$ when $V_i = 3V$. 10

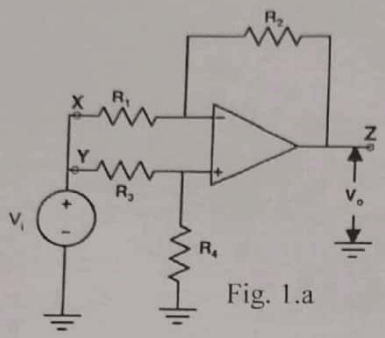


Fig. 1.a

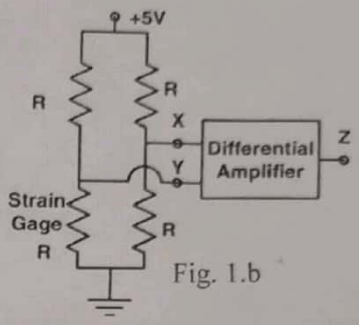
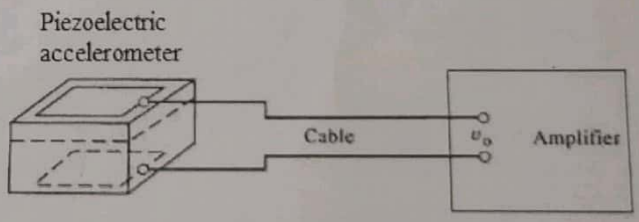


Fig. 1.b

a) Assume the op-amp is ideal and the differential gain to be 10. Find the CMRR.

b) The differential amplifier is connected as shown in Fig.1.b, to a single strain gage bridge. The strain gage resistance varies around its no-load resistance R by ±1%. The input impedance of the amplifier is high compared to the equivalent source resistance of the bridge, and the common mode characteristic of the amplifier is as obtained in part (a). Find the minimum and the maximum output voltage of the amplifier.

2. Consider the characteristics of the piezoelectric accelerometer, the amplifier, and the cable as given in Fig.2. The amplifier is placed 2 m from the sensor. 15



Specifications:

Piezoelectric accelerometer sensitivity	10pC/g
Piezoelectric accelerometer impedance	10GΩ ‖ 100pF
Cable capacitance	30pF/m
Cable insulation resistance	100 GΩ.m

Fig. 2

a) Determine the input capacitance of the amplifier in voltage mode in order to obtain the low corner cut-off frequency of 1 Hz.

b) Design the circuit of the amplifier in charge mode to obtain an output voltage of 1 V/g, having a low corner frequency of 1 Hz.

3. In the circuit given in Fig. 3, the op-amp is ideal and the sensor is RTD having resistance $R_\theta = 1000\ (1 + 0.004\ \theta)\ \Omega$, where θ is temperature in °C. Find the sensitivity of the measurement system in mV/°C. 16mV/C° 10

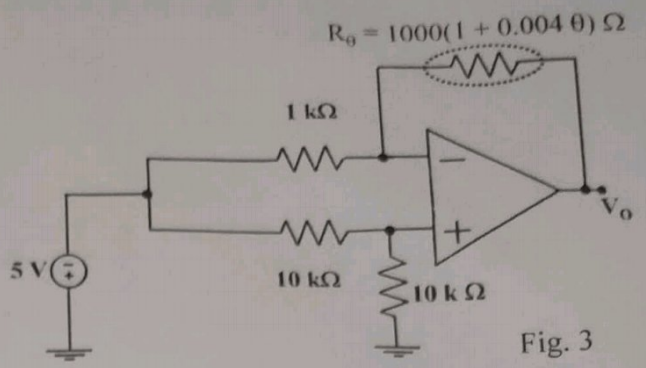


Fig. 3

4. Suppose you are designing a filter for an electrocardiograph (ECG) and you are provided with an ideal op-amp and two capacitors of value $C_1 = 2\ \mu F$ and $C_2 = 10$ nF respectively. Assume the measured ECG signal to have a frequency bandwidth between 0.5 and 100 Hz. The measured ECG is disturbed by interferences coming from respiration artifacts at about 0.3 Hz and electromyography (EMG) signals with frequency bandwidth between 20 and 500 Hz. Design a proper active filter to keep all ECG signal while suppressing the interferences as much as possible. Draw the filter circuit. 10

5. A sample-and-hold circuit has $C = 0.47\ \mu F$, and the ON resistance of FET is 75Ω. For what signal frequency is the sampling capacitor voltage down 3dB from the signal voltage? How does this limit the application of the sample-and-hold?