BME 311
Biomedical Instrumentation I

04 – Instrumentation Amplifier

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Differential Amplifier

Operation modes

- Common mode signals appear simultaneously and in-phase on both inputs.

- The **common mode rejection ratio** (**CMRR**) is a metric used to quantify the ability of the amplifier to reject common-mode signals.

- The **common-mode rejection ratio (CMRR)** is the ratio of the common-mode gain to differential-mode gain.

Instrumentation Amplifier

$$V_0 = A_d V_D + A_{CM} V_{CM}$$

$$CMRR = \frac{A_d}{A_{CM}} = \frac{\left(\frac{R_3}{R_1 + R_3}\right)\left(\frac{R_2 + R_4}{R_2}\right)\left(\frac{R_A}{R_P} + \frac{1}{2}\right) + \left(\frac{R_4}{R_2}\right)\left(\frac{R_B}{R_P} + \frac{1}{2}\right)}{\left(\frac{R_3}{R_1 + R_3}\right)\left(\frac{R_2 + R_4}{R_2}\right) - \left(\frac{R_4}{R_2}\right)}$$

Instrumentation Amplifier

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$$R_4 = R_3, R_2 = R_1 \; and \; R_A = R_B$$

Instrumentation Amplifier

$$V_0 = A_d V_D + A_{CM} V_{CM}$$

$$A_d = \left(\frac{2R_A}{R_P} + 1\right)\left(\frac{R_4}{R_2}\right)$$

$$A_{CM} = \left[\left(\frac{R_4}{R_2 + R_4}\right)\left(\frac{R_2 + R_4}{R_2}\right) - \left(\frac{R_4}{R_2}\right)\right] = 0$$

$$R_4 = R_3, R_2 = R_1 \; and \; R_A = R_B$$

Instrumentation Amplifier

$$\mathrm{CMRR} = \frac{\mathrm{A_d}}{\mathrm{A_{cm}}} \quad ; \quad \mathrm{A_{cm}} \to 0 \quad \mathrm{CMRR} \to \infty$$

$$V_0 = A_d V_D + A_{CM} V_{CM}$$