

BFF3302 SENSOR AND INSTRUMENTATION SYSTEM

Introduction to the Course

By

Ahmad Shahrizan Abdul Ghani (shahrizan@ump.edu.my)

Nafrizuan Bin Mat Yahya (nafrizuanmy@ump.edu.my)

Faculty of Manufacturing Engineering (FKP)

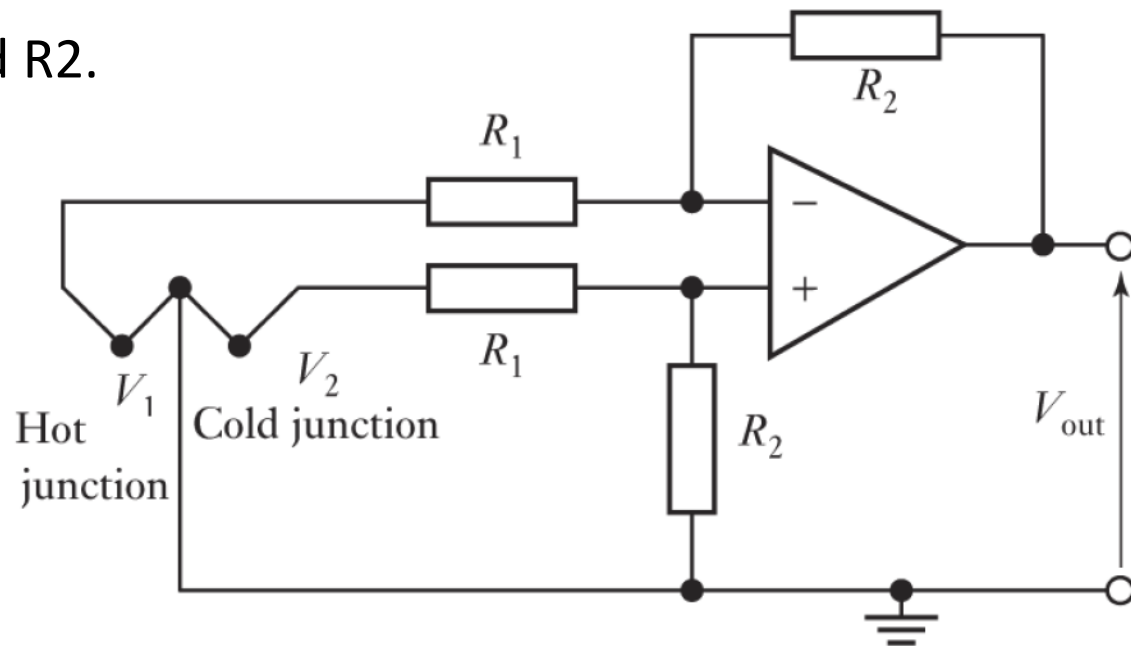
Chapter Description

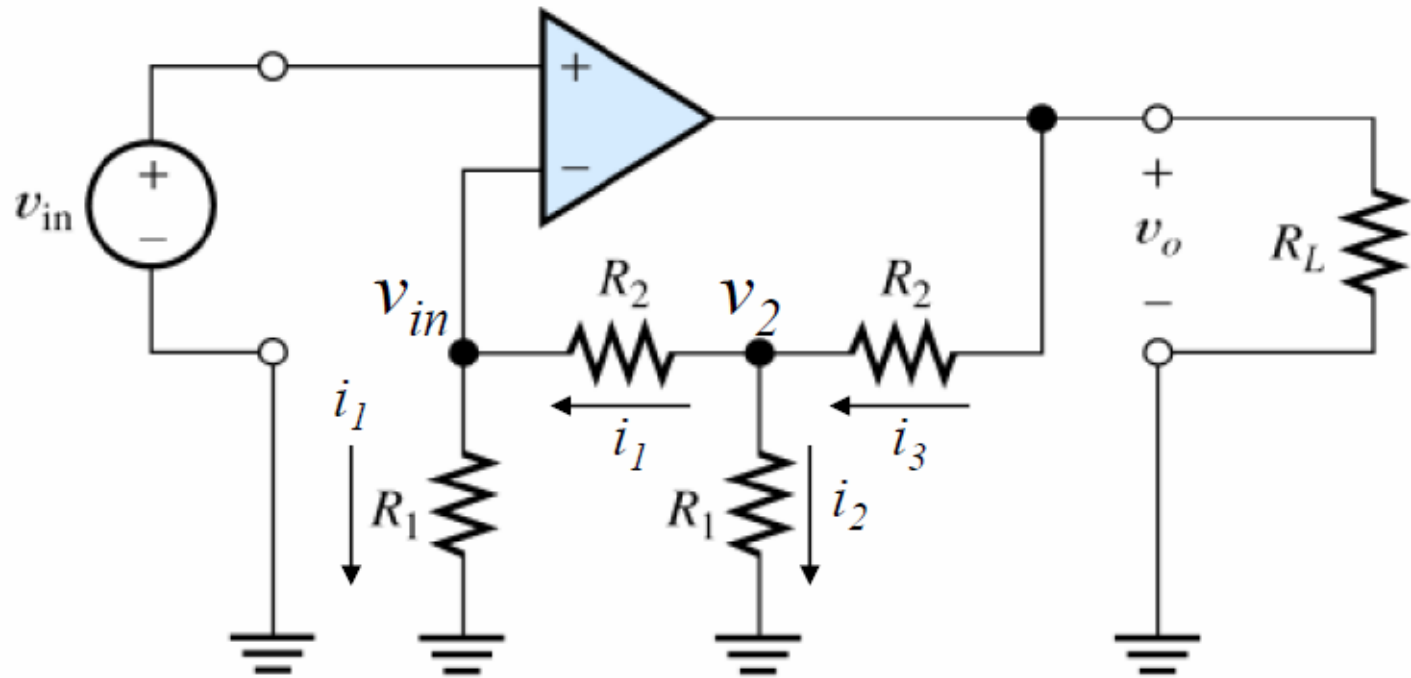
- Aims
 - Obtain basic knowledge about signal conditioning/operational amplifier.
- Expected Outcomes
 - Determine general treatment of instrument elements and their characteristic
 - Analyse transducer elements, intermediate elements, and data acquisition system (DAQ)
- References
 - Introduction to signal processing, instrumentation, and control : an integrative approach / Joseph Bentsman Hackensack, NJ : World Scientific Pub., 2016
 - Transducers for instrumentation / M. G. Joshi, New Delhi, India : Infinity, 2017
 - Instrumentation and measurement in electrical engineering / editor : Harinirina Randrianarisoa, New York : Arcler Press, 2017



Example/Exercise

- Difference voltage between the emfs of the two junctions of thermocouple is amplified.
- If a temperature difference of 10°C \rightarrow emf difference of $530\ \mu\text{V}$, then the values of R_1 and R_2 can be chosen to give a circuit with an output of 10mV .
- Suggest the value of R_1 and R_2 .





Example/Exercise

$$i_1 = \frac{v_{in}}{R_1}$$

$$v_2 = i_1 R_2 + i_1 R_1 = i_1 (R_1 + R_2) = \frac{v_{in}}{R_1} (R_1 + R_2)$$

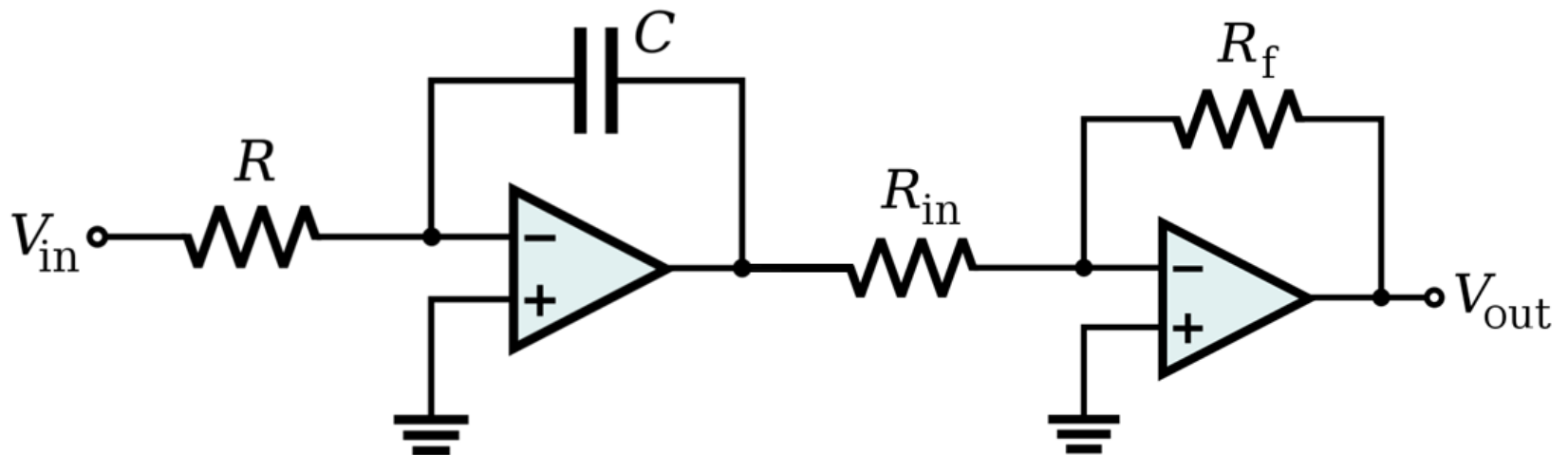
$$i_3 = i_1 + i_2 = \frac{v_{in}}{R_1} + \frac{v_2}{R_1} = \frac{v_{in}}{R_1} + \frac{1}{R_1} \left[\frac{v_{in}}{R_1} (R_1 + R_2) \right] = \frac{v_{in}}{R_1} \left(1 + \frac{R_1 + R_2}{R_1} \right)$$

$$v_o = v_2 + i_3 R_2 = \frac{v_{in}}{R_1} (R_1 + R_2) + \frac{v_{in} R_2}{R_1} \left(1 + \frac{R_1 + R_2}{R_1} \right)$$

$$\frac{v_o}{v_i} = 1 + \frac{R_2}{R_1} + \frac{R_2}{R_1} + \frac{R_2}{R_1} + \frac{R_2}{R_1} \frac{R_2}{R_1} = 1 + 3 \frac{R_2}{R_1} + \left(\frac{R_2}{R_1} \right)^2$$

Example/Exercise

- Consider the circuit below running for 5 seconds. Find $V_{out}(5)$ when:
 - $V_{out}(0) = 0$
 - $V_{in}(t) = 3t$
 - $R = 5M\Omega, C = 5\mu F, R_{in} = 10k\Omega, R_f = 20k\Omega$



Example/Exercise

- Derive the formula for gain, $G=V_o/V_{in}$.

