Circuit Basics

Series Circuits

$$R_T = R_1 + R_2 + \cdots + R_n$$
$$V_s = V_1 + V_2 + \cdots + V_n$$
$$I_T = I_1 = I_2 = \cdots = I_n$$

Parallel Circuits

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_n}$$
$$V_s = V_1 = V_2 = \cdots = V_n$$
$$I_T = I_1 + I_2 + \cdots + I_n$$

Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$if\ v = kc,$

$$\gamma = \frac{1}{\sqrt{1 - k^2}}$$
$$k = \sqrt{1 - \frac{1}{\gamma^2}}$$

$$t = \gamma t_0$$
$$m = \gamma m_0$$
$$l = \frac{l_0}{\gamma}$$

$$E_{rest} = m_0 c^2$$
$$E_{kinetic} = (\gamma - 1) m_0 c^2$$
$$E_{total} = E_{rest} + E_{kinetic}$$
$$E_{total} = \gamma m_0 c^2$$

Proper time/length/mass

Measured by an observer at rest relative to the object.

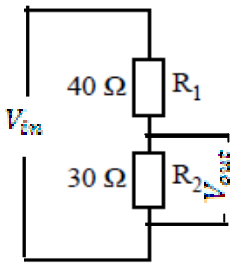
Michelson Morley Exp.

-Provides experimental evidence that the speed of light is same in all directions (in all inertial reference frames)
-The ether does NOT exist

Inertial Reference Frames

-Any reference frame that is travelling at a constant velocity.
-All classical laws of physics are obeyed in inertial reference frames.

Voltage Divider



$$V_{out} = \frac{R_2}{R_1 + R_2} \times V_{in}$$
$$R_2 = \frac{R_1 \times V_{in}}{(V_{in} - V_{out})} - R_1$$

Amplifiers

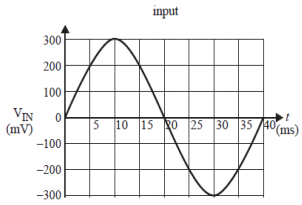


Figure 7a

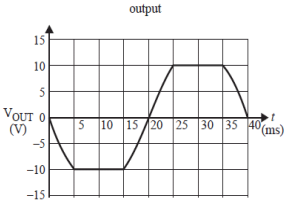
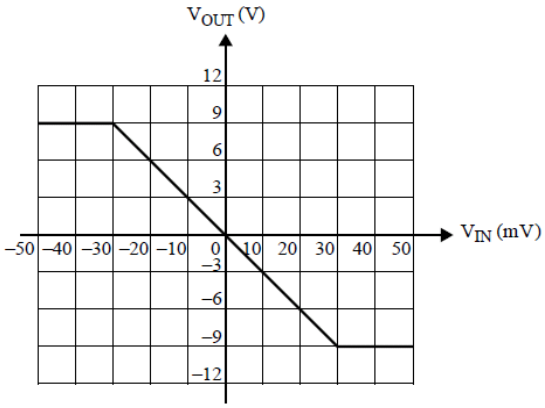


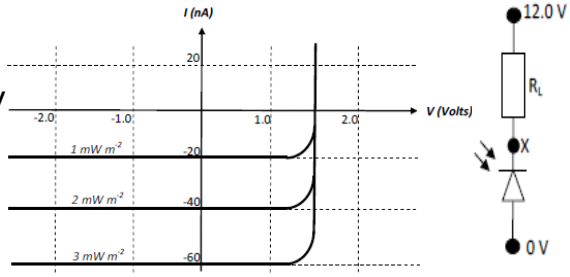
Figure 7b

Inverting amplifier: -signal is flipped



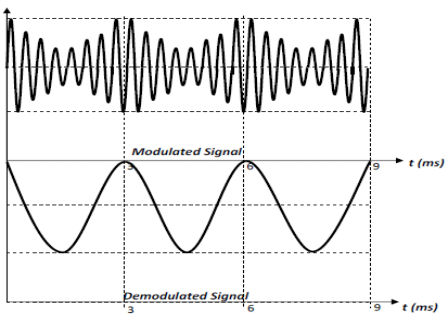
Inverting amplifier: negative gradient

Photodiodes



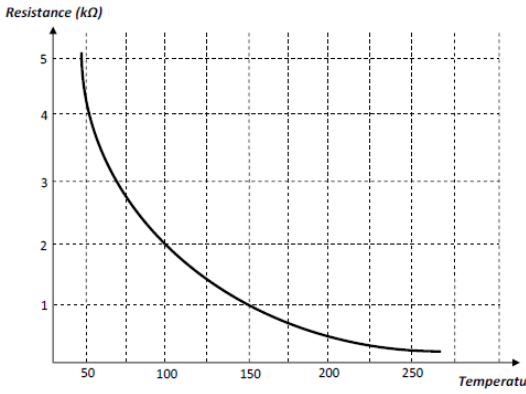
Photodiodes:
-The current allowed to pass through the diode is dependent on the incident light intensity.
-In reverse bias it is in photoconductive

Amplitude Modulation

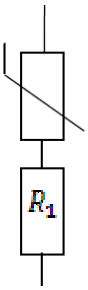


Thermistors

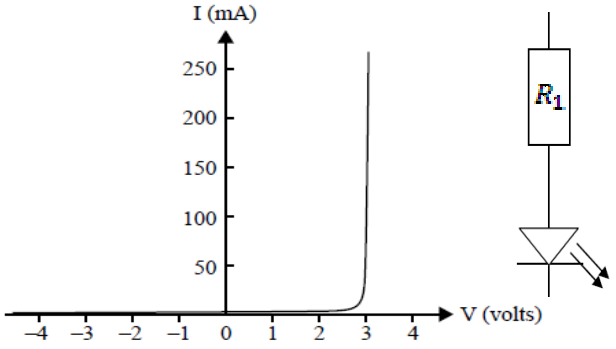
Resistance depends on temperature



As the temperature increases:
-resistance of the thermistor decreases.
-volts across the thermistor decreases.
-the voltage across R_1 increases.
As the temperature decreases:
-resistance of the thermistor increases.
-volts across the thermistor increases.
-the voltage across R_1 decreases.

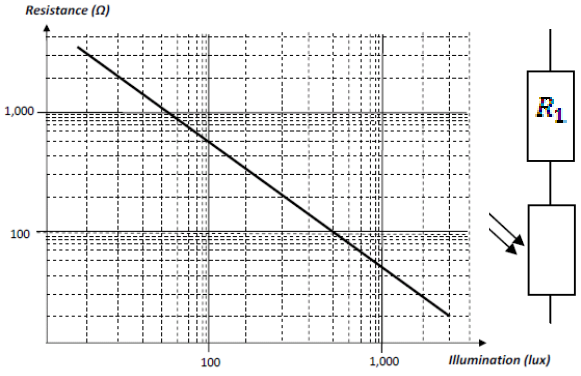


Diodes and Light Emitting Diodes



LED:
Voltage limiting device.
If in forward bias, current can flow through it.
Light output increases with greater current.

Light Dependent Resistors



As the light intensity increases (brighter):
-resistance of the LDR decreases.
-voltage across the LDR decreases.
-the voltage across R_1 increases.
As the light intensity decreases (darker):
-resistance of the LDR increases.
-voltage across the LDR increases.
-the voltage across R_1 d ecreases.