RESEARCHING PROJECT

" SOIL PH METER DESIGN "

[4TH WEEK REPORT]

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2019-2020

OUTLINE

- Amplifier(Operational amplifier):
  - Inverting Op-Amp
  - Non-Inverting Op-Amp
  - Summing amplifier
- Missing and Difficulty

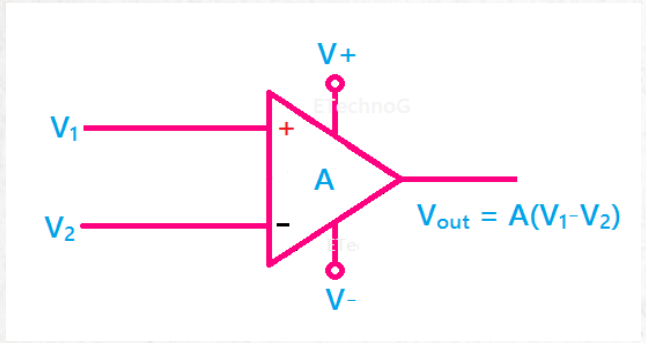
AMPLIFIER

- Why do we have to built Amplifier?
  - Because we need to increase or decrease input.(Gain >1, Gain<1)
- How can Amplifier help in our circuit?
  - Because of our sensor generate small voltage input, so micro-controller is hard to analyze result to show output.
- How can we apply Amplifier to our circuit?
  - We need read sensor's datasheet for output and micro-controller's ADC input that can generate to output.
- How can we built Amplifier for our sensor?
  - We have to know Gain and bandwidth for our sensor to micro-controller then we can built Amplifier for it.
- ✓ We use Operational Amplifier (Op-Amp) for built our Amplifier.

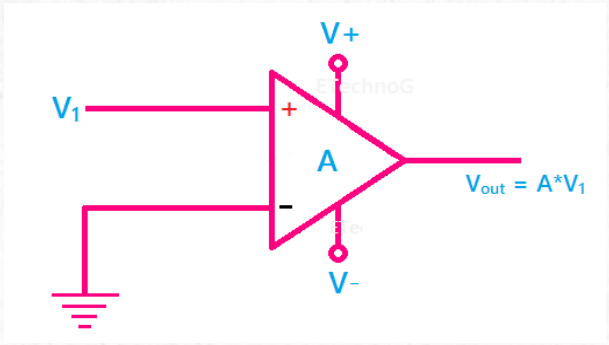
OPERATIONAL AMPLIFIER

Circuit symbol of the operational amplifier:

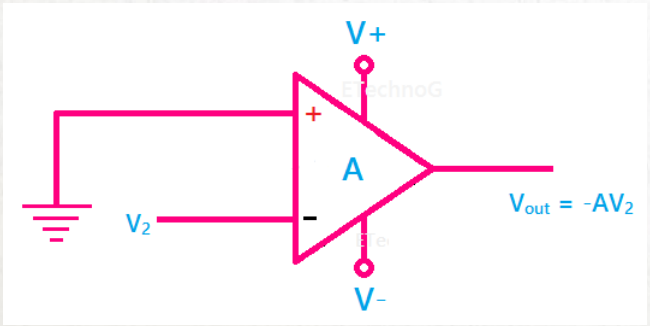
- 2 input and 1 output
- Most of the operational amplifiers consist of two power supplies(positive and negative power supply)



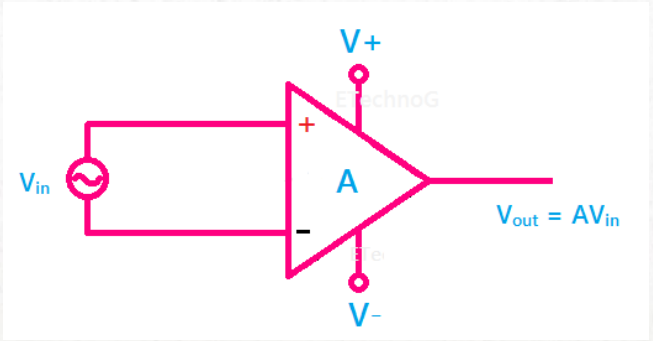
Vout = A(V1-V2)



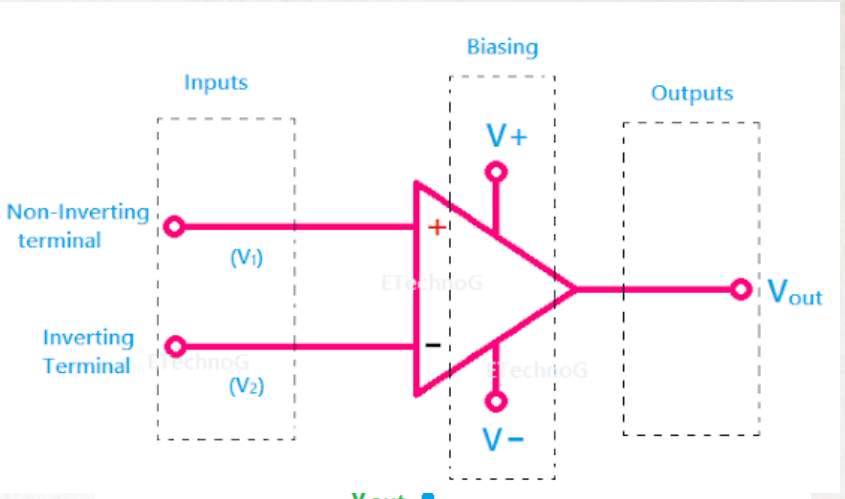
Vout = A.V1

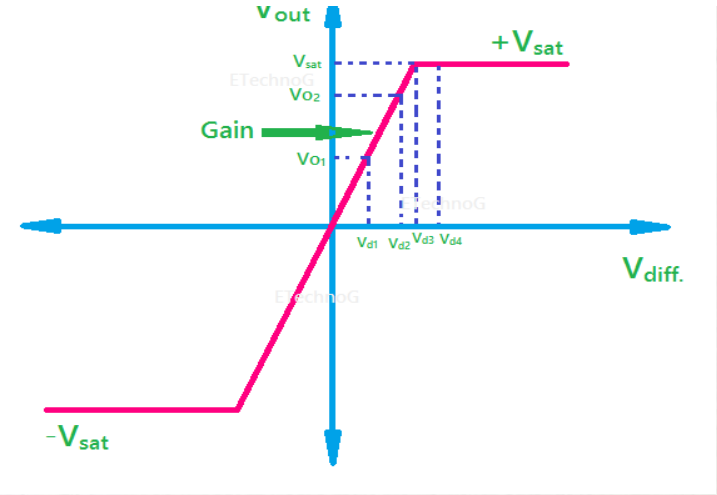


Vout = A.V2



Vout = A.Vin (high gain)





Value of gain is used in range of 10^5 to 10^6. Example Vin = 1mV so Vout = 1m x 10^5 = 100V.

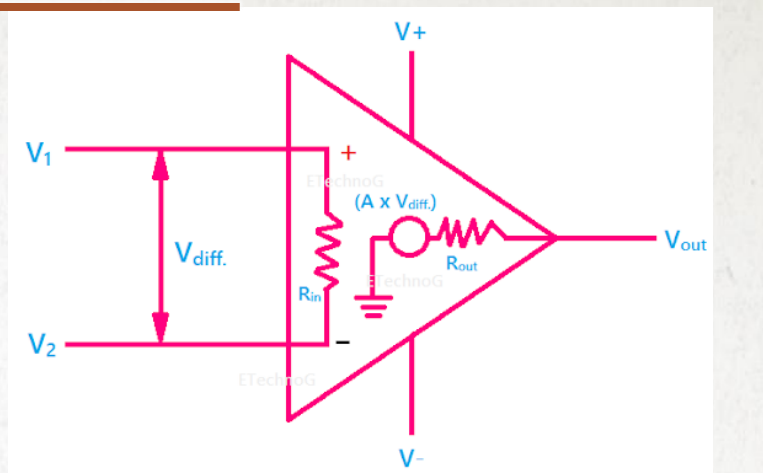
OPERATIONAL AMPLIFIER

Ideal of the operational amplifier Characteristics:

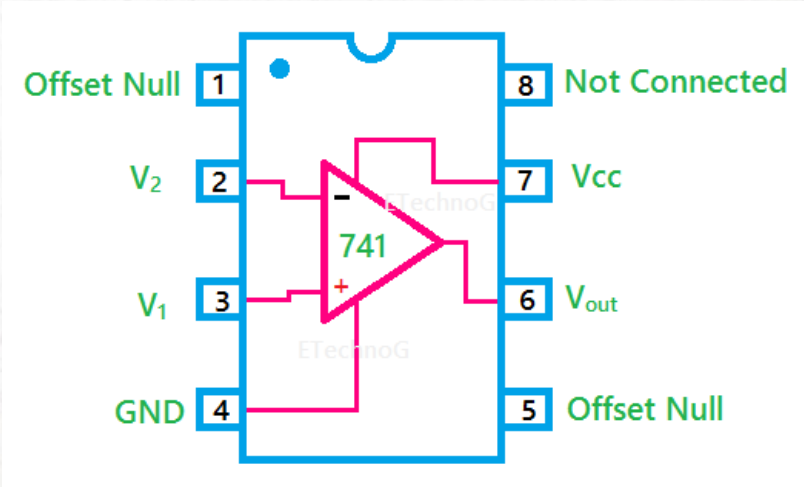
- Input Impendent: $R_{in}=\infty(M\Omega)$
- Output Impendent: $R_{out}=0(\Omega)$
- Open-loop Gain($A = \infty$)
- $V_{out}=0$ when $V_{in}=0$;
- Infinite Bandwidth and Slew Rate
- Infinite CMRR(Common mode rejection ratio)

OP-AMP 741 Specification

Parameters	Values
Input Impendent	2MΩ
Output Impendent	75Ω
Open-loop Gain	10^5
Offset Voltage	1mV
Slew Rate	0.5 V/μs
CMRR	70 – 90 dB



$R_{in} = \infty$ and $R_{out} = 0$ => BW =(0 - ∞) = ∞
=> A = ∞ => $V_{out} = 0$;



INVERTING OP-AMP

By KCL: $I_{in} = If$

For $I_{in} = \frac{V_{in} - Vx}{R_{in}}$ and $I_f = \frac{V_x - Vo_{ut}}{R_f}$; $Vx = 0$

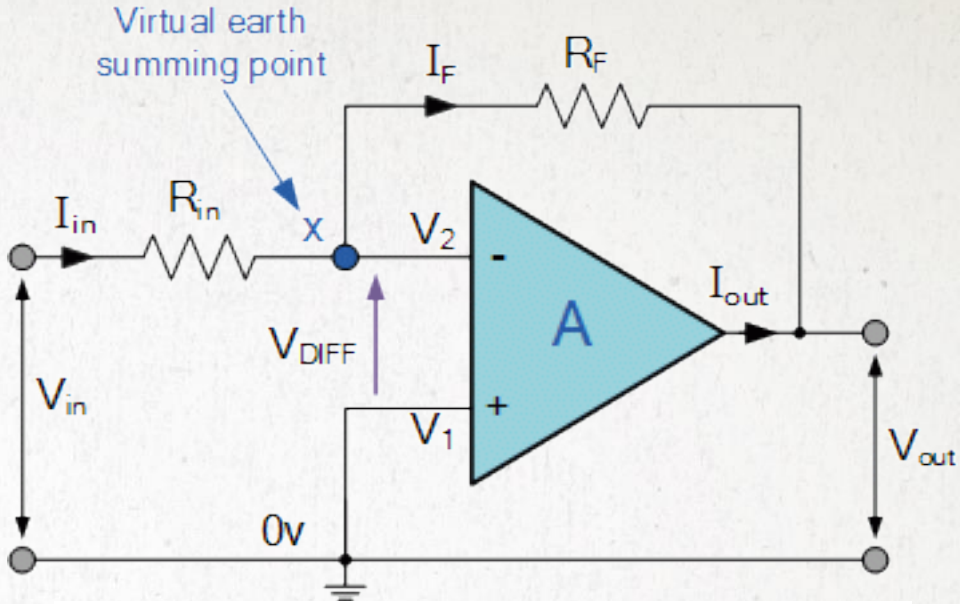
$\Rightarrow \frac{V_{in}}{R_{in}} = -\frac{V_{out}}{R_f} \Rightarrow \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$

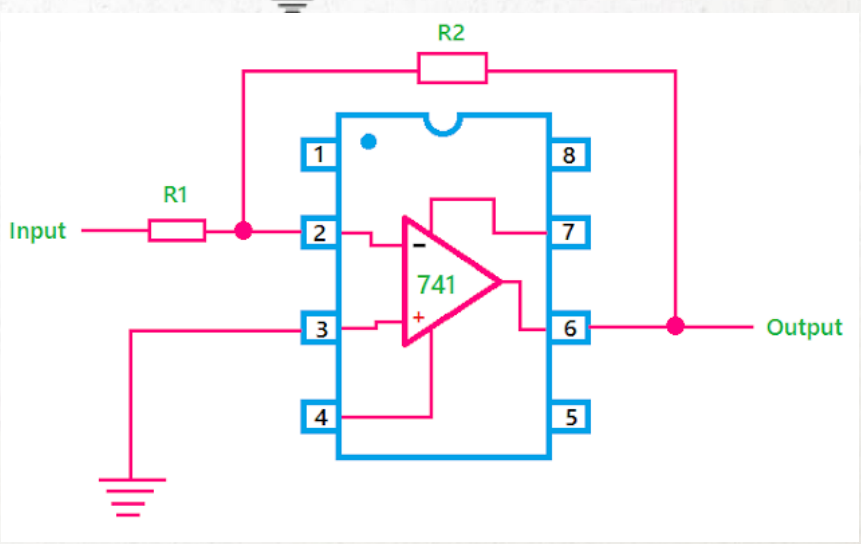
So $Gain(A_v) = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$

Thus $V_{out} = -Av.Vin$

Example: $R_{in} = R_f = 1k$

And $V_{in} = 2V \Rightarrow A_v = -1 \Rightarrow V_{out} = -2V$





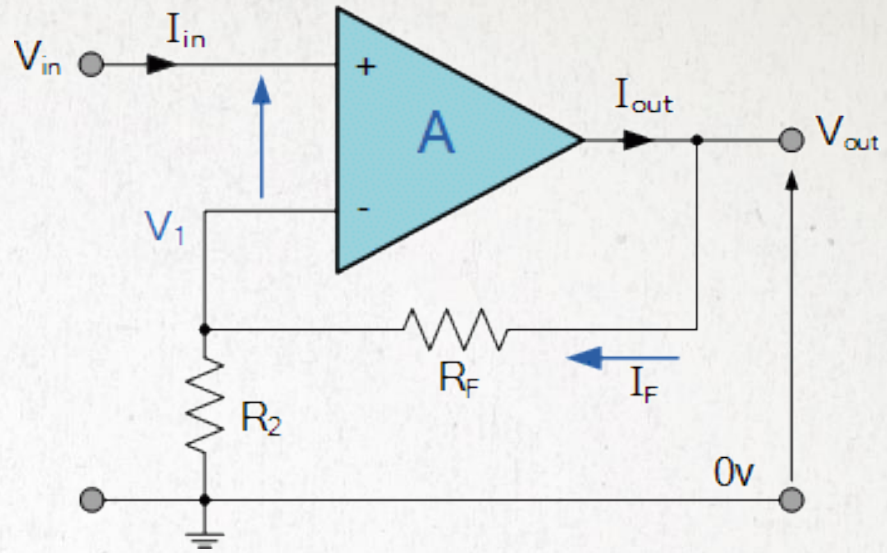
NON-INVERTING OP-AMP

By $V^{+} = V^{-} \Rightarrow V_1 = V_{in}$

For $V_1 = \frac{R_2}{R_2+Rf} \times V_{out}$ and $V_{out} = \frac{R_2+Rf}{R_2} \times Vin$

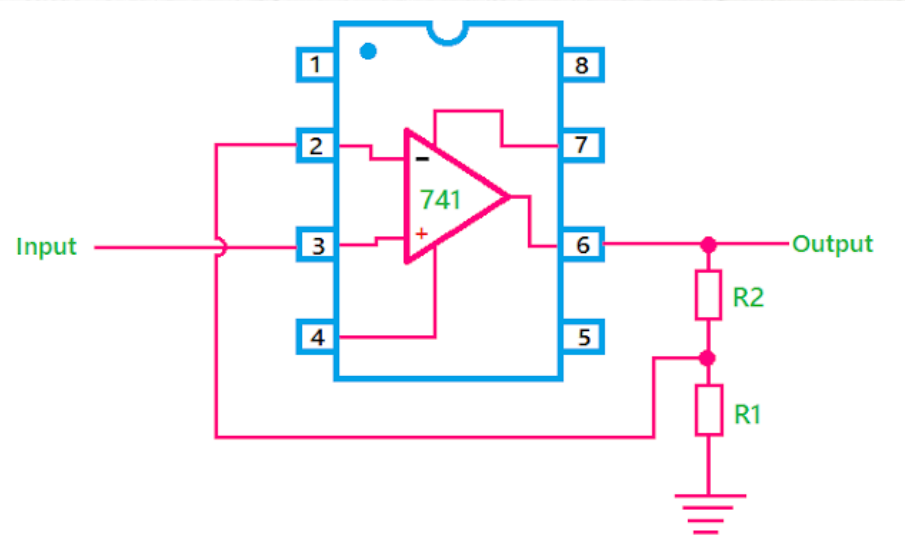
So $Gain(A_v) = \frac{V_{out}}{V_1} = \frac{R_2+Rf}{R_2} = 1 + \frac{R_f}{R_{in}}$

Thus $V_{out} = Av.Vin = \left(1 + \frac{Rf}{R2}\right).Vin$



Example: $R_2 = R_f = 1k$

And $V_{in} = 2V \Rightarrow A_v = 2 \Rightarrow V_{out} = 4V$

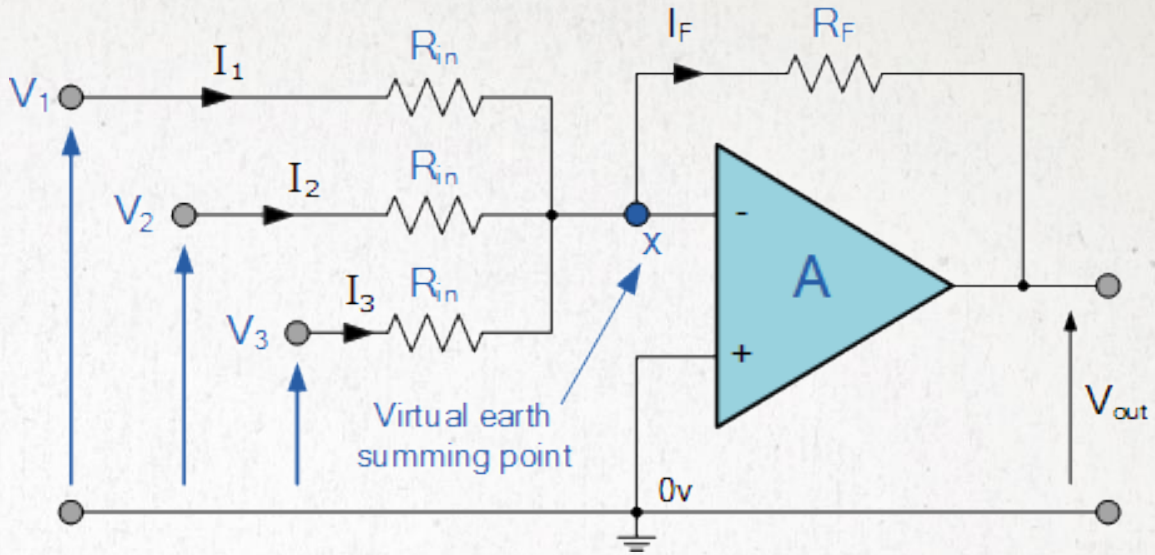


SUMMING AMPLIFIER(INVERTING OP-AMP)

By KCL: $I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$

$$\frac{V_{out}}{R_f} = If$$

then, $-Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$



- Case: R1 = R2 = R3 =R_F => $R_{in} = R_F$ Thus V_{out} = - (V1+V2+V3)
- Case: R1 ≠ R2 ≠ R3⇒ $\frac{R_F}{R_1} \neq \frac{R_F}{R_2} \neq \frac{R_F}{R_3}$ Thus V_{out}= -(AV1 + BV2 + CV3)
- Case: R1 = R2 = R3 =R_{in} ≠ R_F Thus Vout = $-\frac{R_F}{R_{in}}(V1 + V2 + V3)$

SUMMING AMPLIFIER(NON-INVERTING OP-AMP)

$$I_{R1} + I_{R2} = 0 \quad (KCL)$$

$$\frac{V_1 - V+}{R_1} = \frac{V_2 - V+}{R_2} = 0$$

$$\therefore \left(\frac{V_1}{R_1} - \frac{V+}{R_1}\right) + \left(\frac{V_2}{R_2} - \frac{V+}{R_2}\right) = 0$$

If we make the two input resistances equal in value, then $R_1 = R_2 = R$.

$$V+ = \frac{\frac{V_1}{R} + \frac{V_2}{R}}{\frac{1}{R} + \frac{1}{R}} = \frac{V_1 + V_2}{\frac{R}{2}}$$

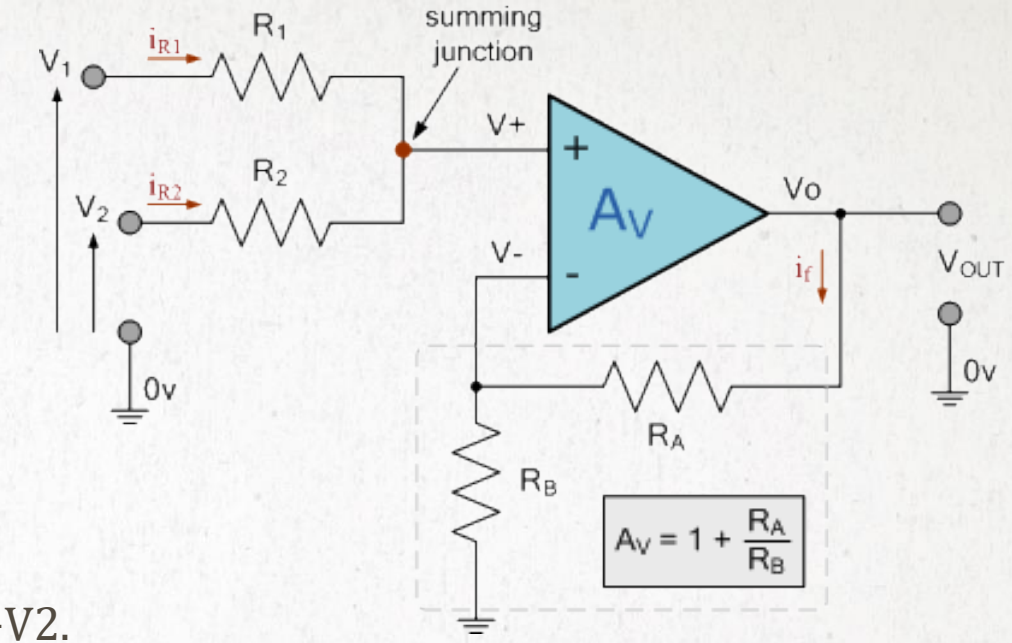
$$\text{Thus} \quad V+ = \frac{V_1 + V_2}{2}$$

The standard equation for the voltage gain of a non-inverting summing amplifier circuit is given as:

$$A_V = \frac{V_{OUT}}{V_{IN}} = \frac{V_{OUT}}{V+} = 1 + \frac{R_A}{R_B}$$

$$\therefore \quad V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] V+$$

$$\text{Thus:} \quad V_{OUT} = \left[1 + \frac{R_A}{R_B}\right] \frac{V_1 + V_2}{2}$$



❖ Case R_A=R_B

Thus V_{out}= V1 +V2.

❖ Case R1 ≠ R2 and RA ≠ RB :

$$Vout = (1 + \frac{RA}{RB})(\frac{R2}{R1+R2} \times V1 + \frac{R1}{R1+R2} \times V2)$$

DIFFICULTY AND MISSING

- Difficulty :
  - Many resource to read and learn
  - Don’t have enough time.
- Missing:
  - Lately work

PLANNING FOR 1ST MONTH

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Goal
1st Week	Research	Meeting	Learn Amplifier	Presentation	Learn Filter	Learn Filter
2nd Week	REST DAYS					
3rd Week	Learn Filter	Learn Filter	Learn Filter	Learn Filter	Learn Filter	Learn Filter
4th Week	Learn Amplifier	Learn Amp Meeting	Learn Amplifier	Presentation Learn Amp	Learn Amplifier	Learn Amplifier

Start : ***10/08/2020***

PLANNING FOR 2ND MONTH

Week	Monday	Tuesday	Wednesday	Thursday	Friday	Goal
5th Week	Build Filter pH & LCD	Meeting Build Filter	Filter Build filter	Presentation Build Amp	Build Amplifier	Design Amplifier
6th Week	Build Amplifier	Meeting Learn stm32	Learn STM32 Test LCD/pH	Presentation Write Code	Write Code STM32	Start STM32
7th Week	Write Code STM32	Meeting Write Code	Write Code STM32	Presentation Write code	Finish STM32 Code	Finish STM32 Code
8th Week	Draw case for hardware	Meeting Draw case	Draw case for hardware	Presentation Draw case	Print 3D case	Build case Finish Job

Start : ***06/09/2020***

THANK YOU