RESEARCHING PROJECT
“ SOIL PH METER DESIGN ”

[4^{TH} WEEK REPORT]

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2019-2020

OUTLINE

- ❖ Amplifier(Operational amplifier):
  - ➢ Inverting Op-Amp
  - ➢ Non-Inverting Op-Amp
  - ➢ Summing amplifier
  - ➢ Differential amplifier
  - ➢ Op-amp as Integrator
  - ➢ Op-amp as Differentiator
- ❖ Missing and Difficulty

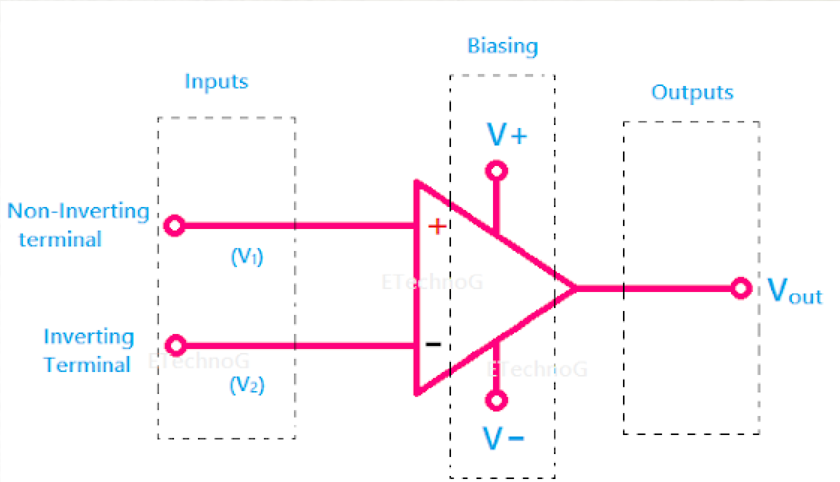
AMPLIFIER

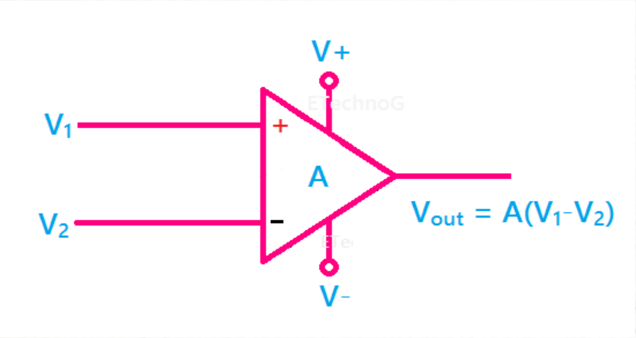
- ❖ Why do we have to built filter?
  - ➢ Because we need to increase or decrease input.(Gain >1, Gain<1)
- ❖ How can filter help in our circuit?
  - ➢ Because of our sensor generate small voltage input, so micro-controller is hard to analyze result to show output.
- ❖ How can we apply filter to our circuit?
  - ➢ We need read sensor’s datasheet for output and micro-controller’s ADC input that can generate to output.
- ❖ How can we built filter 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

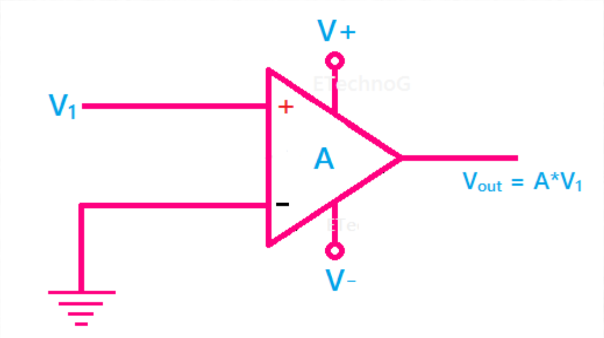
Circuit symbol of the operational amplifier:

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

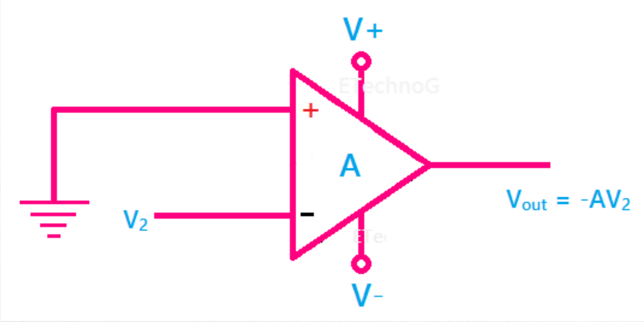




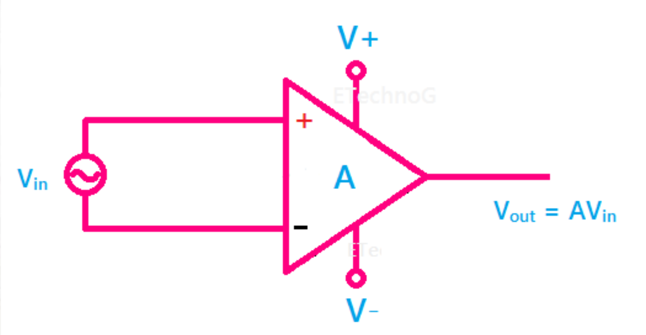
$V_{out} = A(V1-V2)$



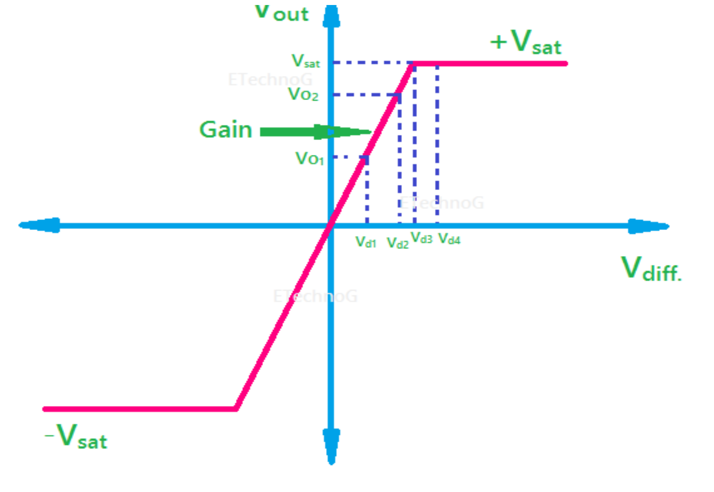
$V_{out} = A.V1$



$V_{out} = A.V2$



Vout = A.Vin (high gain)

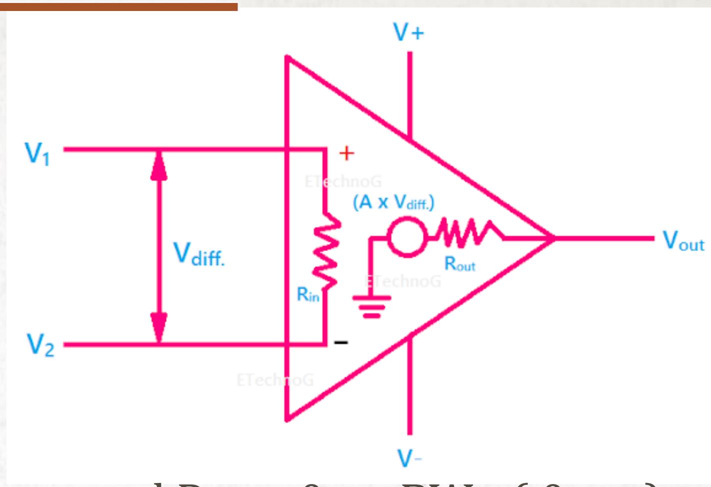


Value of gain is used in range of 10^5 to 10^6. Example Vin = 1mV so Vout = 1m x 10^5 = 100V.

OPERATIONAL AMPLIFIER

Ideal of the operational amplifier Characteristics:

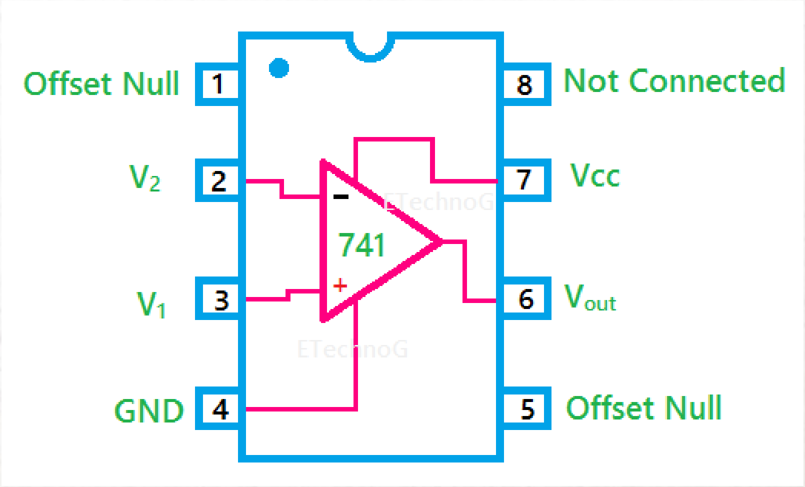
- Input Impendent: R_{in}=∞(MΩ)
- Output Impendent: R_{out} =0(Ω)
- Open-loop Gain(A = ∞)
- V_{out} =0 when V_{in} =0;
- Infinite Bandwidth and Slew Rate
- Infinite CMRR(Common mode rejection ratio)



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

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



INVERTING OP-AMP

By KCL: $I_{in} = If$

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

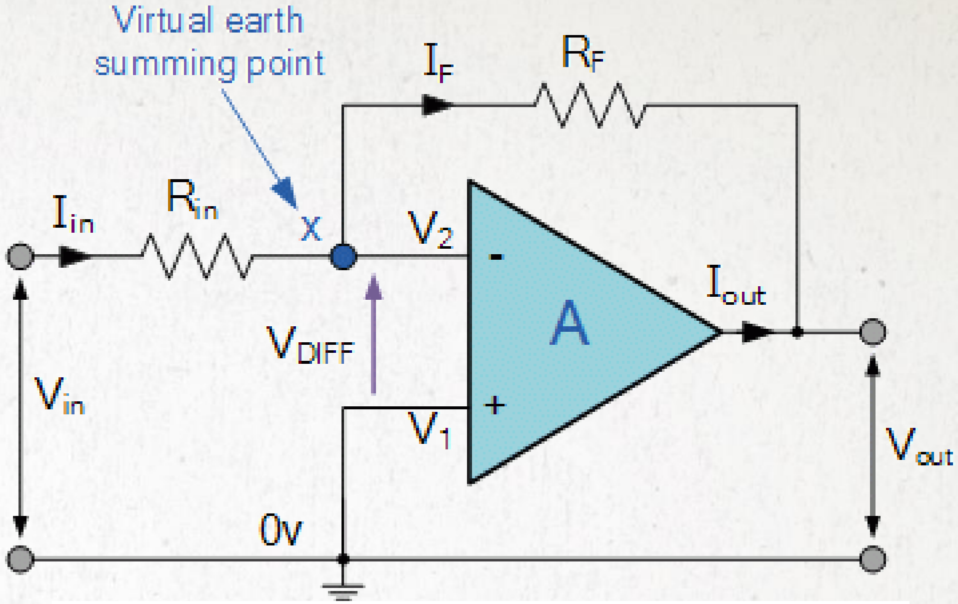
$$\Rightarrow \frac{V_{in}}{R_{in}} = -\frac{V_{out}}{R_f} \Rightarrow \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$$

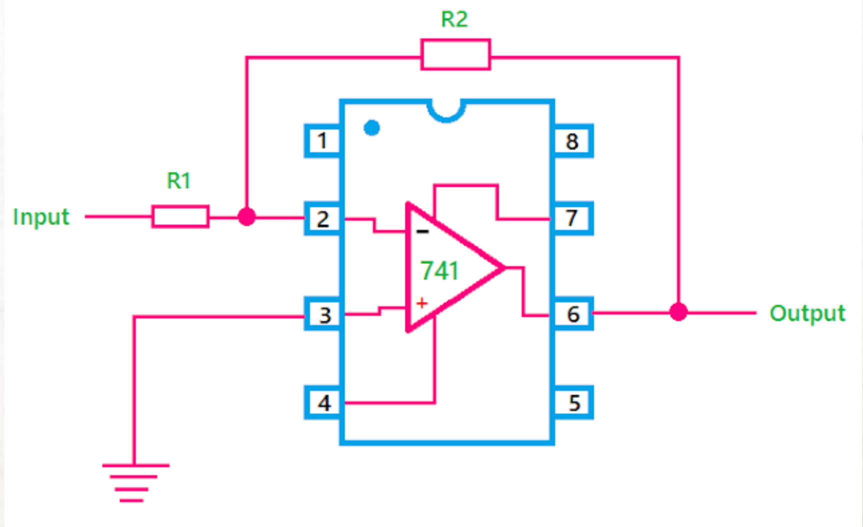
So $Gain(A_v) = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$

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

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

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





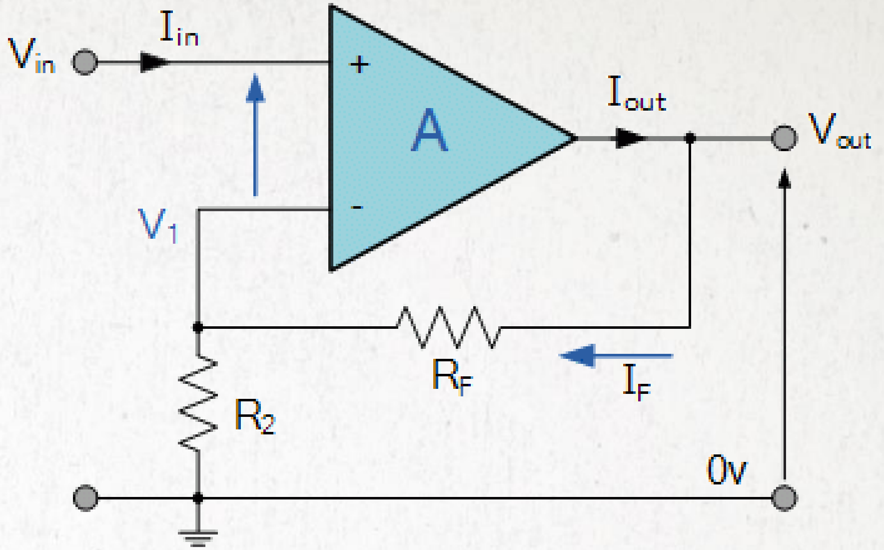
NON-INVERTING OP-AMP

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

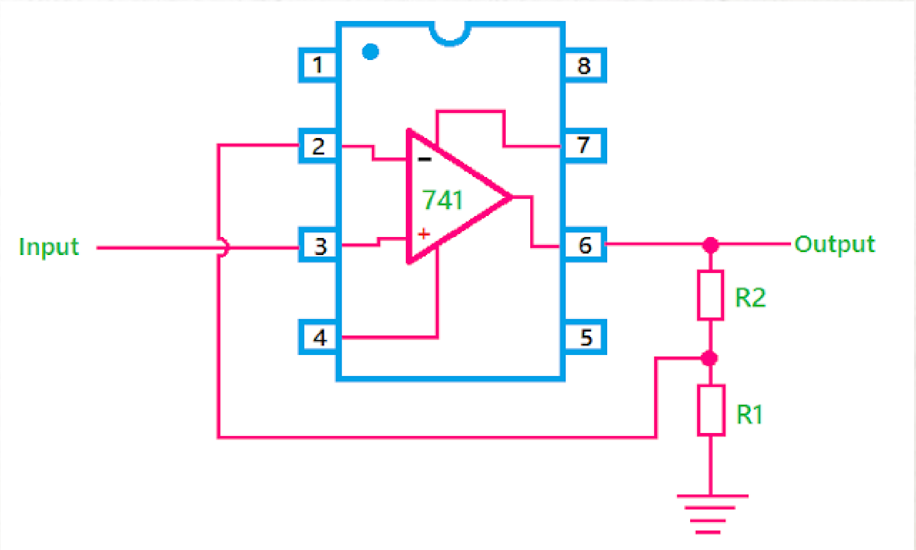
For $V_1 = \frac{R_2}{R_2+Rf} \times V_{out}$ and $V_{out} = \frac{R_2+Rf}{R_2} \times Vin$

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

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



Example: $R_2 = R_f = 1k$
And $V_{in} = 2V \Rightarrow A_v = 2 \Rightarrow V_{out} = 4V$

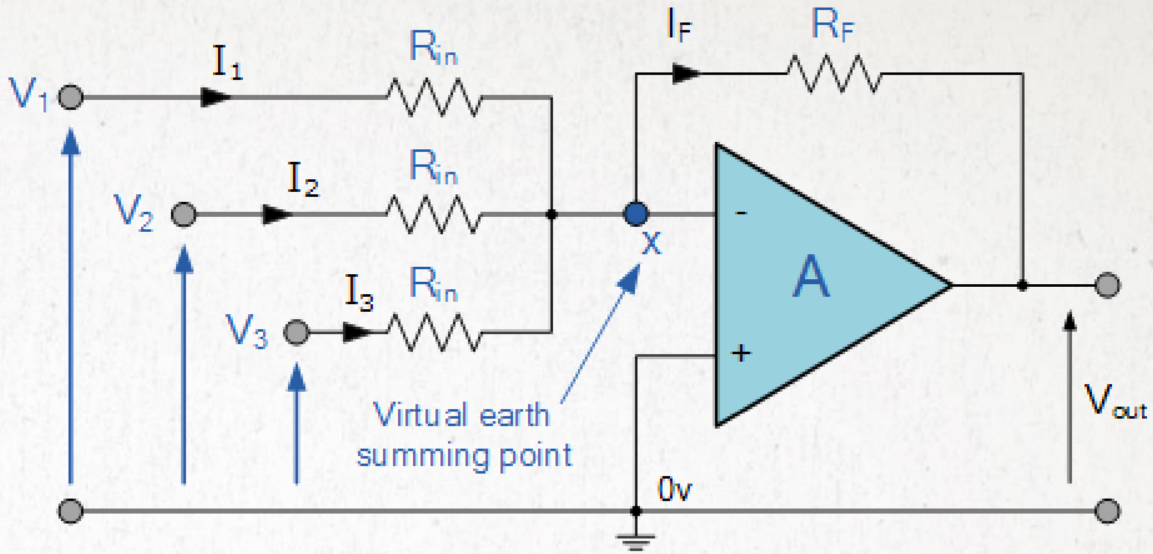


SUMMING AMPLIFIER(INVERTING OP-AMP)

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 $R_1 = R_2 = R$.

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

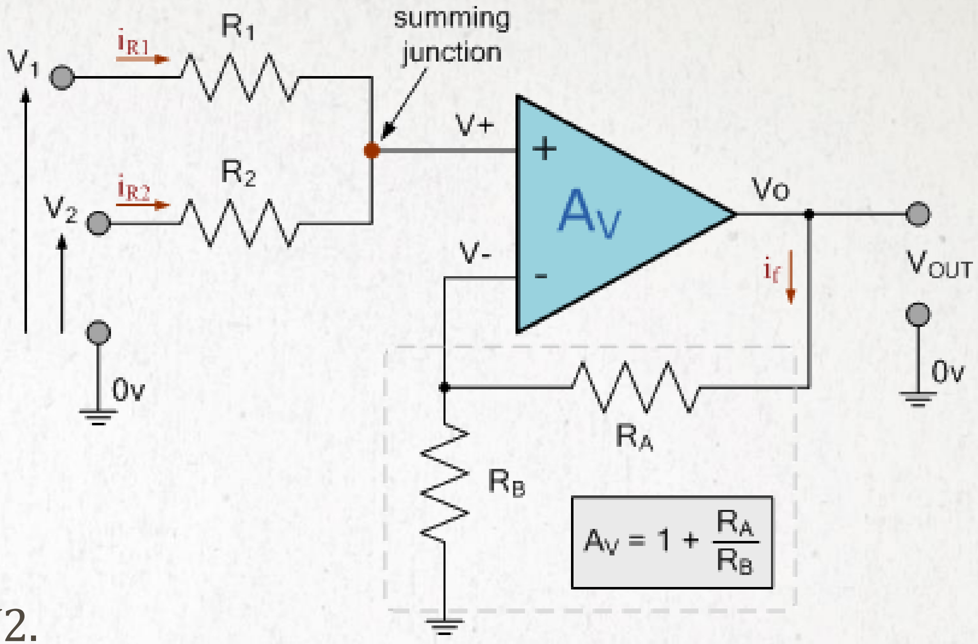
$$\text{Thus} \quad V+ = \frac{V_1 + V_2}{2}$$

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 :

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

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