SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF

ELECTRONICS AND INSTRUMENTATION ENGINEERING

LAB MANUAL

VII SEMESTER

EI8762– Instrumentation System Design Laboratory

Regulation– 2017

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EI8762 INSTRUMENTATION SYSTEM DESIGN LABORATORY

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OBJECTIVES:

1. To obtain adequate knowledge in design of various signal conditioning circuits, instrumentation systems.
2. To impart design knowledge of controller, control valve and transmitter.
3. To acquire the knowledge of piping diagram of industrial standard
4. To make the students aware of industry project, planning and scheduling.

LIST OF EXPERIMENTS:

1.	Design of Instrumentation amplifier.
2.	Design of active filters – LPF, HPF and BPF
3.	Design of regulated power supply and design of V/I and I/V converters.
4.	Design of linearizing circuits and cold–junction compensation circuit for thermocouples.
5.	Design of signal conditioning circuit for Strain gauge and RTD.
6.	Design of Orifice plate and Rotameter.
7.	Design of Control valve (sizing and flow-lift characteristics)
8.	Design of PID controller (using operational amplifier and microprocessor)
9.	Design of a multi-channel data acquisition system.
10.	Design of multi range DP transmitter.
11.	Piping and Instrumentation Diagram – case study.
12.	Preparation of documentation of instrumentation project and project scheduling for the above case study. (Process flow sheet, instrument index sheet and instrument specifications sheet, job scheduling, installation procedures and safety regulations).
13.	One or two experiments beyond syllabus.

CYCLE 1

1. Design of Instrumentation amplifier.
2. Design of active filters – LPF, HPF and BPF
3. Design of regulated power supply and design of V/I and I/V converters.
4. Design of linearizing circuits and cold–junction compensation circuit for thermocouples.
5. Design of signal conditioning circuit for strain gauge and RTD.
6. Design of Orifice plate and Rotameter.
7. Design of Control valve (sizing and flow-lift characteristics)

CYCLE 2

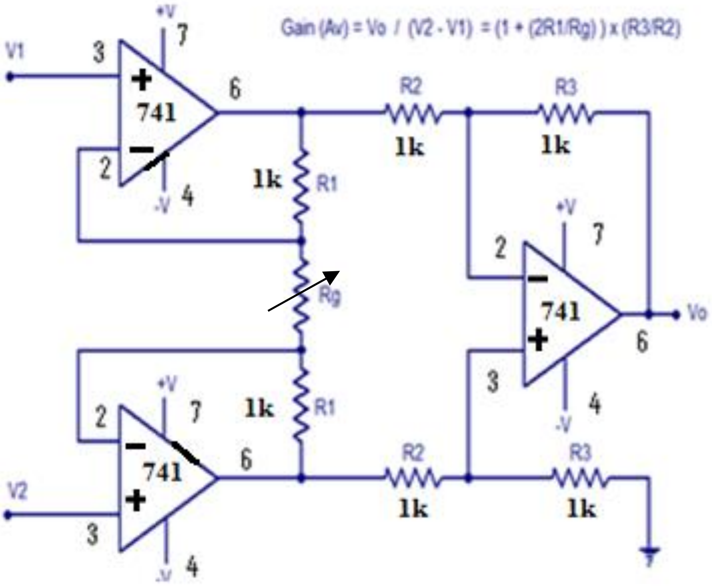
8. Design of PID controller (using operational amplifier and microprocessor)
9. Design of a multi-channel data acquisition system
10. Design of multi range DP transmitter
11. Piping and Instrumentation Diagram – case study.
12. Preparation of documentation of instrumentation project and project scheduling for the above case study. (Process flow sheet, instrument index sheet and instrument specifications sheet, job scheduling, installation procedures and safety regulations).

EXPERIMENTS BEYOND SYLLABUS

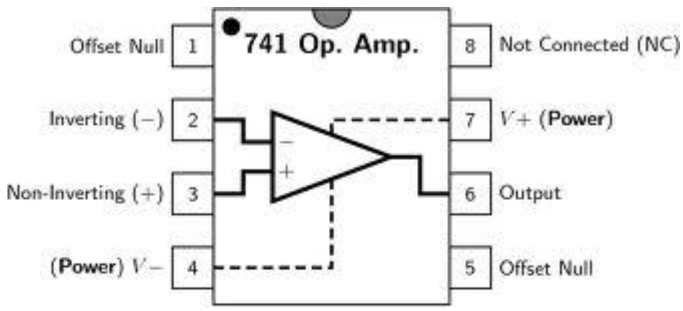
13. Design and implementation of signal conditioning circuit for RTD using instrumentation amplifier.

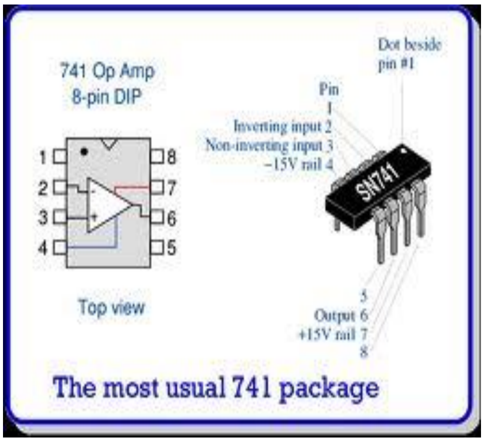
CONTENTS

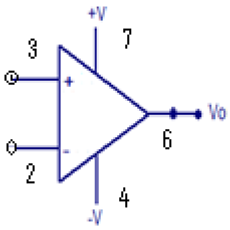
CIRCUIT DIAGRAM



PIN DETAILS







EX.NO:1	DESIGN OF INSTRUMENTATION AMPLIFIER
DATE:	

AIM:

To design an instrumentation amplifier based on the three operational amplifier configuration with a differential gain of 100.

DESIGN:

$$v_{01} = \left(1 + \frac{R_1}{R_G}\right) V_1 - \left(\frac{R_1}{R_G}\right) V_2 \text{ - - - - - - } (1)$$

$$v_{02} = \left(1 + \frac{R_2}{R_G}\right) V_2 - \left(\frac{R_2}{R_G}\right) V_1 \text{ - - - - - - } (2)$$

Subtracting (2) – (1)

Assume $R_1 = R_2 = R$

$$v_{02} - v_{01} = \left[\left(1 + \frac{R}{R_G}\right) V_2 - \left(\frac{R}{R_G}\right) V_1 \right] - \left[V_1 \left(1 + \frac{R}{R_G}\right) + \left(\frac{R}{R_G}\right) V_2 \right]$$

$$v_{02} - v_{01} = \left[V_2 + V_2 \left(\frac{R}{R_G}\right) - V_1 \left(\frac{R}{R_G}\right) - V_1 - V_1 \left(\frac{R}{R_G}\right) + V_2 \left(\frac{R}{R_G}\right) \right]$$

$$= V_2 + \frac{2RV_2}{R_G} - \frac{2RV_1}{R_G} - V_1$$

$$= V_2 - V_1 + (V_2 - V_1) \frac{2R}{R_G}$$

$$\boxed{v_{02} - v_{01} = (V_2 - V_1)\left(1 + \frac{2R}{R_G}\right) R_2/R_1}$$

<u>DESIGN</u>

Rg Value=?

Gain=100

R_g=?

Assume $R_1=R_2=R_3=1K\Omega$

$$\text{Gain} = \left(1 + \frac{2R}{Rg}\right) \frac{R3}{R2}$$

$$100 = \left(1 + \frac{2x10^3}{Rg}\right) \frac{1k}{1k}$$

$$99 = \frac{2x10^3}{Rg}$$

$$R_g = 20\Omega$$

APPARATUS REQUIRED:

1. Ic 741
2. Multimeter
3. Resistors 1k,10k, 20Ω some no's
4. Breadboard and connecting wires.

THEORY:

Instrumentation Amplifier (IA) is a differential amplifier designed to amplify the output of sensors and transducers. An instrumentation amplifier amplifies very small signals with large common mode signals. Instrumentation Amplifier has high CMRR. The IA consists of three operational amplifier out of which two operational amplifier used are non – inverting amplifier and the third operational amplifier is the differential amplifier. The advantages are high CMRR and high input impedance. Remote sensors like temperature, flow and pressure sensors produce small voltages with noise. These noise can be fitered and the signal from the sensors can be amplified to reasonable level.

741 FEATURES

- Large input voltage range
- No latch-up
- High gain
- Short-circuit protection
- No frequency compensation required
- Same pin configuration as ua709

741 USAGE

- Summing amplifier
- Voltage follower
- Integrator
- Active filter
- Function generator

TABULATION

S.No	**V_1 (mV)**	**V_2 (mV)**	**$(V_2 - V_1)$ (mV)**	**Practical V_0 (V)**	**Theoretical V_0 (V)**	**Gain = $V_0 / (V_2 - V_1)$**
1.						
2.						
3.						
4.						
5.						

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Measure the input voltages at V_{in1} and V_{in2} (always keep $V_{in2} > V_{in1}$) using multimeter.
3. The difference in V_{in1} and V_{in2} is amplified as per the design.
4. Check the Theoretical and practical output voltage (vo).
5. Calculate the gain value.

RESULT:

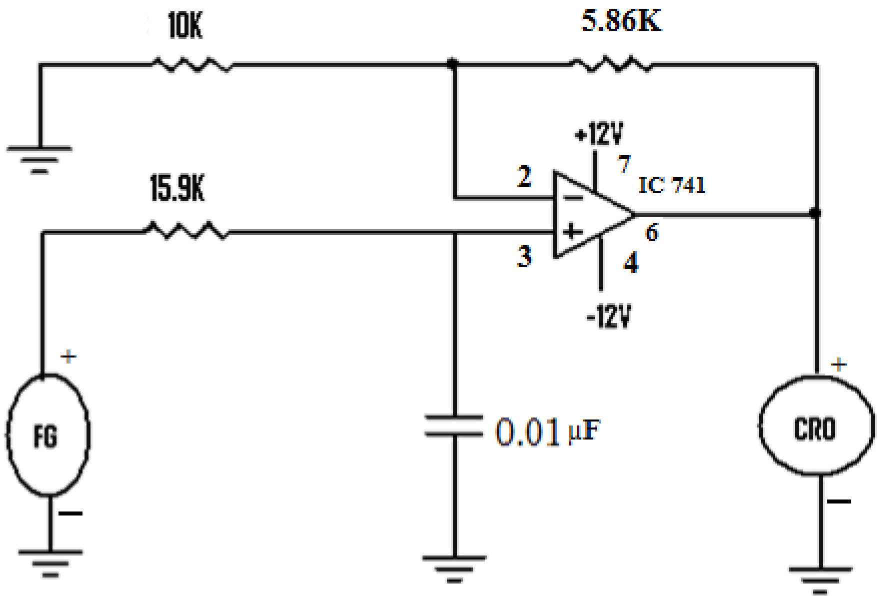
Thus an instrumentation amplifier was designed using op-Amp IC 741.

EXERCISE:

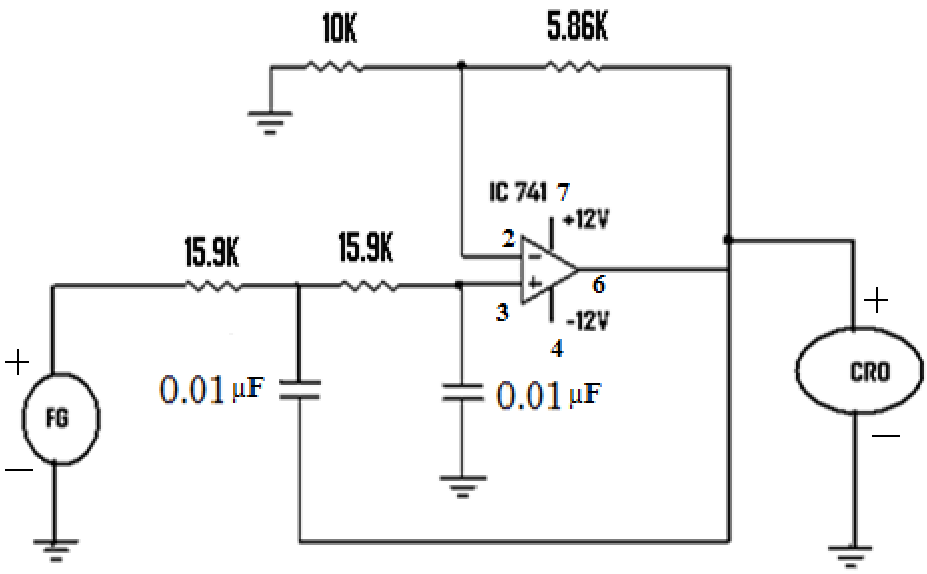
1. Design an Instrumentation amplifier for a gain of 200.
2. Design an Instrumentation amplifier for a gain of 50.
3. Design an Instrumentation amplifier for a gain of 300.

CIRCUIT DIAGRAM:

FIRST ORDER LPF



SECOND ORDER BUTTERWORTH FILTER LPF



EX.NO:2(a)	DESIGN OF FIRST ORDER & SECOND ORDER ACTIVE LOW PASS FILTER
DATE:	

AIM:

To design an active,

1. First order
2. Second order Butterworth type low pass filter with cut off frequency of 1 KHz.

THEORY:

An electric filter is a frequency selective circuit that passes a specified band of frequencies and blocks (or) attenuates signals of frequencies outside this band. Filters may be classified in a number of way Analog (or) Digital Passive (or) Active Audio (AF) (or) Radio frequency Analog filters are designed to process analog signals, while digital filters process analog signal using digital techniques. Depending on type of elements used in their construction, filters may be classified as active (or) passive.

Elements used in passive filters are resistor, capacitor and inductors. Active filters, on the other hand employ transistor (or) op –Amps in addition to resistors and capacitor. For example, RC filters are commonly used for audio (or) low frequency operation, whereas LC (or) crystal filters are employed at RF (or) high frequencies especially because of their high Q value, the crystals provide more stable operation at high frequencies.

Active filters are mostly used in field of Communication, and Signal processing, Radio, Television, RADAR, space satellites and bio-medical equipment. Each of these filters is using an Op-Amp as the active element and resistors and capacitors as passive elements. The order of filter is determined by gain of the filter. For example first order high pass filter, the gain rolls of at 20dB/decade in stop band. For the second order filter the gain rolls of at 40dB/decade. For first order high pass filter gain increases at a rate of 20dB/decade in stop band for second order, gain increases at rate of 40dB/decade in stop band.

TABULATION AND MODEL GRAPH:

FIRST ORDER LPF **V_{in} =1.3v**

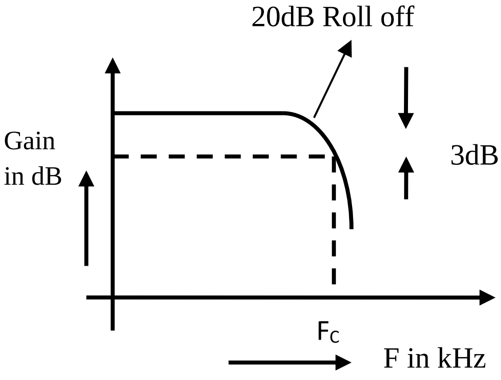
S.No	Frequency (Hz)	O/P voltage (V_o)	Gain=20log $_{10}$ (V_o /V_{in})
1	200		
2	400		
3	600		
4	800		
5	1K		
6	1.2k		
7	1.4k		
8	1.6k		
9	1.8k		
10	2 K		
11	4 K		
12	5 K		
13	6 K		
14	8k		
15	10k		

SECOND ORDER LPF **V_{in}=1.3v**

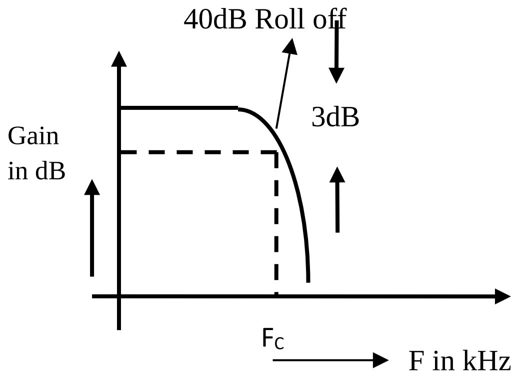
S.No	Frequency (Hz)	O/P voltage (V_o)	Gain=20log $_{10}$ (V_o /V_{in})
1	200		
2	400		
3	600		
4	800		
5	1K		
6	1.2k		
7	1.4k		
8	1.6k		
9	1.8k		
10	2 K		
11	4 K		
12	5 K		

13 14 15	6 K 8k 10k		

FIRST ORDER LPF



SECOND ORDER LPF



DESIGN:

FIRST ORDER BUTTERWORTH LPF

The closed loop gain of amplifier (or) gain of filter

$A_0 = 1+R_f/R_1$

$R_f = 5.86$ KΩ,

$R_1 =$ 10 KΩ

$A_0 = 1+5.86$ KΩ /10 KΩ =1.586

The cutoff frequency of first order filter is given by $F_c = 1/2\pi RC$

Assume C=0.01μF, R=?

1 KHz = $\frac{1}{2\pi\times0.01\times10^{-6}\times R}$

$\boxed{R=15.9\ K\Omega}$

SECOND ORDER BUTTERWORTH LPF

The transfer function of second order Low pass Butterworth filter is $A_0/(s^2+\alpha s+1)$, α =damping coefficient = 1.414 & A_0 =gain. This is called as Butterworth filter. Audio filters are usually Butterworth.

$F_c = \frac{1}{2\pi RC}$ =1 KHz

$F_c = \frac{1}{2\pi\sqrt{R1R2C1C2}}$

Then pass band gain $A_o = 3 - \alpha = 3 - 1.414 = 1.586$. The transfer function of second order Low pass Butterworth filter is = $\frac{1.586}{(s2+1.414s+1)}$

$A_0 = 1+R_F/R_1$

$\boxed{R_F = 5.86}$

$R_1 = 10K\Omega$

So, $A_0 = 1+ \frac{5.86}{10} = 1.586$

Then pass band gain, $3 - \alpha = 3 - 1.414 = 1.586$

$$F_c = \frac{1}{2\pi\sqrt{R1R2C1C2}}$$

Assume R = 15.9 KΩ, C=?

F =1 KHz

So, $C = \frac{1}{Fc*2\pi R} = \frac{1}{1000x2x3.14x15.9k} = 0.01\mu F$.

APPARATUS REQUIRED:

1. IC 741-1No.
2. Resistors (5.86K - 1No., 10K - 2Nos.)
3. Capacitor (0.01μF - 1No.)
4. AFO & CRO
5. Bread board and Connecting wires.

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The input voltage V_{in} is given, keeping it constant. The input frequency is varied from 100Hz to maximum frequency (10 KHz) and the output voltage is noted.
3. The gain is calculated by using the formula $20\log_{10}(V_o/V_{in})$.
4. The 3dB line is drawn and the cutoff frequency f_c is found, this is compared with theoretical value.

RESULT:

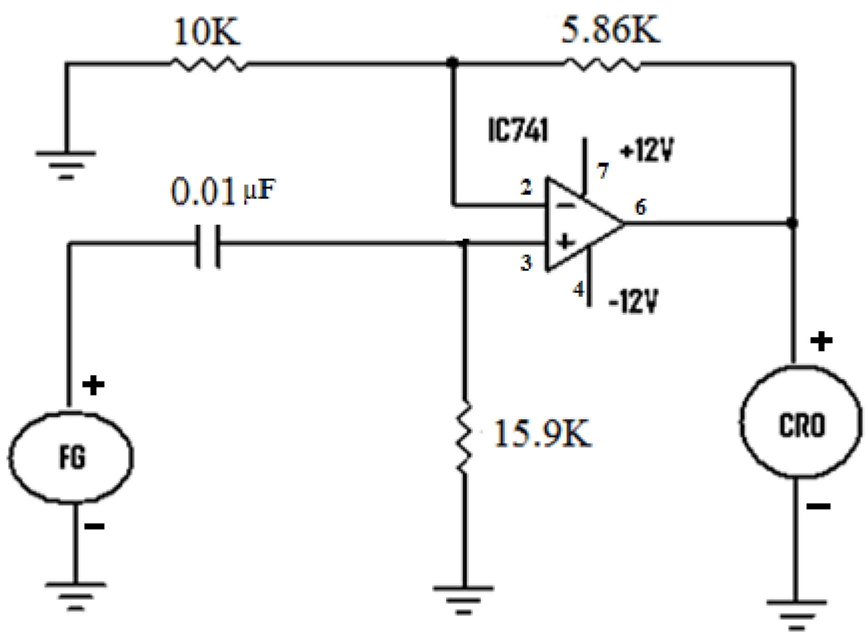
Thus the first order & second order Low pass filter was designed and the cut-off frequency was calculated from the graph.

EXERCISE:

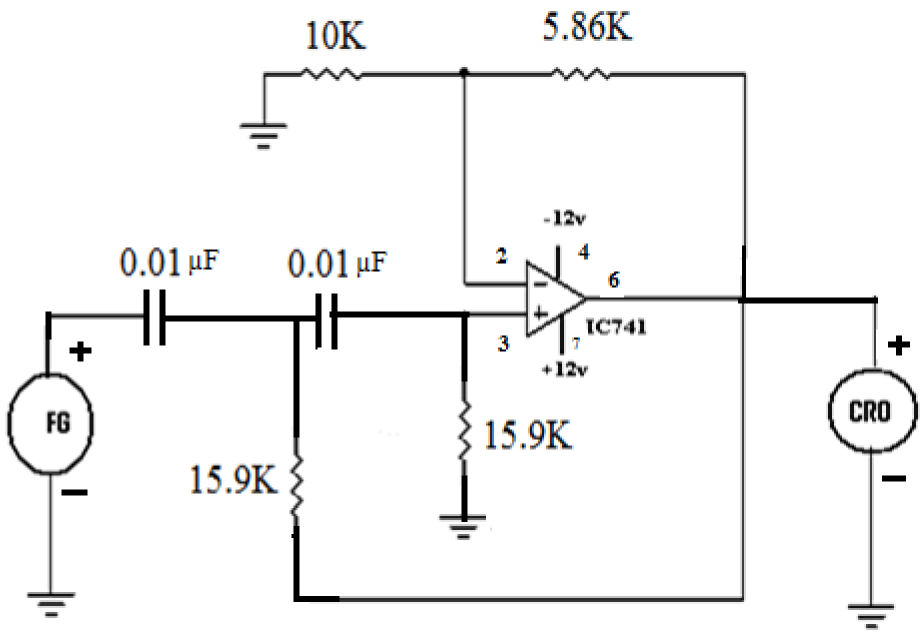
1. Design a low pass filter for a cut off frequency of 1.5KHZ.
2. Design a low pass filter for a cut off frequency of 3KHZ.
3. Design a low pass filter for a cut off frequency of 4KHZ.

CIRCUIT DIAGRAM:

FIRST ORDER HPF



SECOND ORDER HPF



EX.NO:2(b)	DESIGN OF FIRST ORDER & SECOND ORDER ACTIVE HIGH PASS FILTER
DATE:	

AIM:

To design an active,

1. First order
2. Second order Butterworth type High-pass pass Filter with cut off frequency of 1 KHz

DESIGN:

FIRST ORDER BUTTERWORTH HPF

The closed loop gain of amplifier (or) gain of filter

$A_0 = 1+R_f/R_1$

$R_f = 5.86$ KΩ,

$R_{1=}$ 10 KΩ

$A_0 = 1+5.86$ KΩ /10 KΩ =1.586

The cutoff frequency of first order filter is given by $F_c = 1/2\pi RC$

Assume C=0.01µF, R=?

1 KHz = $\dfrac{1}{2\pi\times 0.01\times 10^{-6}\times R}$

$\boxed{R=15.9\ K\Omega}$

SECOND ORDER BUTTERWORTH HPF

The transfer function of second order High pass Butterworth filter is $A_0/(s^2+\alpha s+1)$, α =damping coefficient = 1.414 & $A_{0\,=}$gain. This is called as Butterworth filter. Audio filters are usually Butterworth.

$F_c = \dfrac{1}{2\pi RC}$ =1 KHz

$F_c = \dfrac{1}{2\pi\sqrt{R1R2C1C2}}$

Then pass band gain $A_o = 3 - \alpha = 3 - 1.414 = 1.586$. The transfer function of second order Low pass Butterworth filter is = $\dfrac{1.586}{(s2+1.414s+1)}$

$A_0 = 1+R_F/R_1$

$\boxed{R_F = 5.86}$

$R_1 = 10K\Omega$

So, $A_0 = 1 + \frac{5.86}{10} = 1.586$

Then pass band gain, $3 - \alpha = 3 - 1.414 = 1.586$

$F_c = \frac{1}{2\pi\sqrt{R1R2C1C2}}$

Assume R = 15.9 KΩ, C=?

F_c =1 KHz

So, $C = \frac{1}{Fc*2\pi R} = \frac{1}{1000x2x3.14x15.9K} = 0.01\mu F.$

APPARATUS REQUIRED:

1. IC 741-1 No.
2. Resistors (15.9K - 2Nos, 5.86K-2Nos 10K - 2Nos.)

B 3. Capacitor (0.01µF - 2Nos)

4. AFO & CRO
5. Bread board and Connecting wires.

THEORY:

An electric filter is a frequency selective circuit that passes a specified band of frequencies and blocks (or) attenuates signals of frequencies outside this band. Filters may be classified in a number of ways

i) Analog (or) Digital
ii) Passive (or) Active
iii) Audio (AF) (or) Radio frequency (RF)

Analog filters are designed to process analog signals, while digital filters process analog signal using digital techniques. Depending on type of elements used in their construction, filters may be classified as active (or) passive. Elements used in passive filters are resistor, capacitor and inductors. Active filters . For example, RC filters are commonly used for audio (or) low frequency operation, whereas LC (or) crystal filters are employed at RF (or) high frequencies especially because of their high Q value, the crystals provide more stable operation at high frequencies.

Active filters are mostly used in field of Communication, and Signal processing, Radio, Television, RADAR, space satellites and bio-medical equipment.Each of these filters is using an Op-Amp as the active element and resistors and capacitors as passive elements. The order of filter is determined by gain of the filter. For example first order high pass filter, the gain rolls of at 20dB/decade in stop band. For the second order filter the gain rolls of at 40dB/decade. For first order high pass filter gain increases at a rate of 20dB/decade in stop band for second order, gain increases at rate of 40dB/decade in stop band.

TABULATION AND MODEL GRAPH:

FIRST ORDER HPF

V_{in} =1.3v

S.No	Frequency (Hz)	O/P voltage (V_o)	Gain=20log $_{10}$ (V_o /V_{in})
1	200		
2	400		
3	600		
4	800		
5	1K		
6	1.2k		
7	1.4k		
8	1.6k		
9	1.8k		
10	2 K		
11	4 K		
12	5 K		
13	6 K		
14	8k		
15	10k		

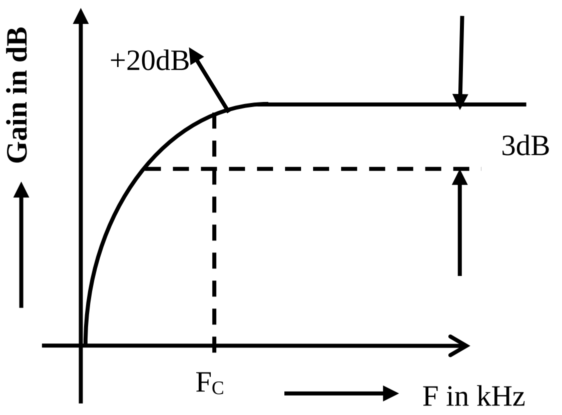
SECOND ORDER HPF

V_{in}=1.3v

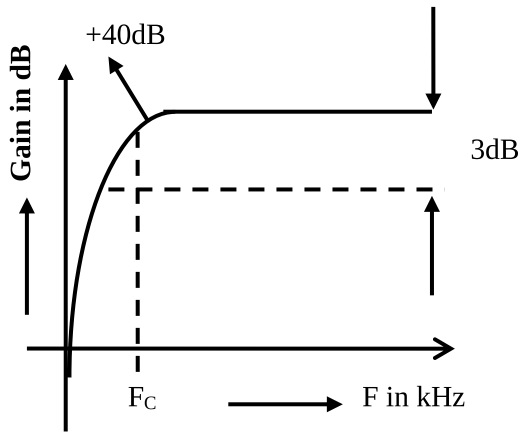
S.No	Frequency (Hz)	O/P voltage (V_o)	Gain=20log $_{10}$ (V_o /V_{in})
1	200		
2	400		
3	600		
4	800		
5	1K		
6	1.2k		
7	1.4k		
8	1.6k		
9	1.8k		
10	2 K		
11	4 K		
12	6 K		
13	8k		
14	10k		

MODEL GRAPH:

FIRST ORDER HPF



SECOND ORDER HPF



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The input voltage is applied to the input side of the circuit.
3. The O/P voltage is measured by varying frequency of input signal.
4. The readings are tabulated.
5. The graph is plotted between frequency and voltage gain. Also Cut-off frequency is calculated and verified.

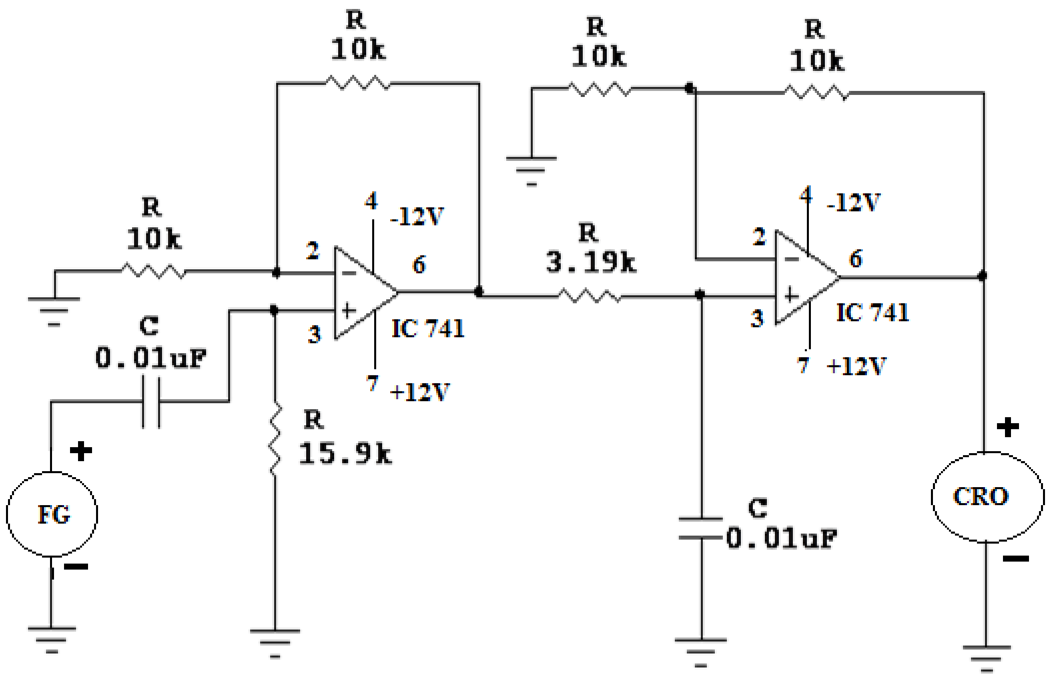
RESULT:

Thus the first order & second order high pass filter was designed and the cut-off frequency was calculated from the graph.

EXERCISE:

1. Design a high pass filter for a cut off frequency of 2.5KHZ.
2. Design a high pass filter for a cut off frequency of 10KHZ.
3. Design a high pass filter for a cut off frequency of 5KHZ.

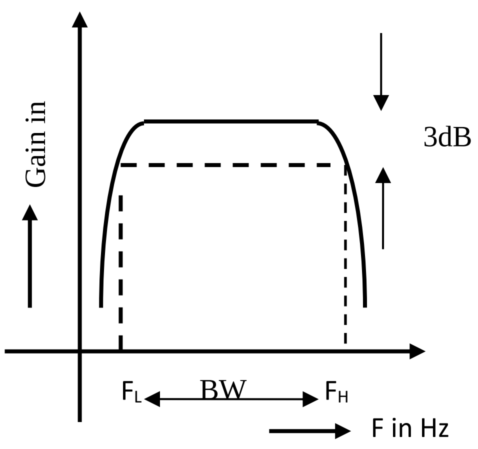
CIRCUIT DIAGRAM:



TABULATION: Vin = 1.3v

S.No	Frequency(Hz)	O/P voltage (V_o)	Gain=20log $_{10}$ (V_o /V_{in})
1	200		
2	400		
3	600		
4	800		
5	1K		
6	1.2k		
7	1.4k		
8	1.6k		
9	1.8k		
10	2 K		
11	4 K		
12	5 K		
13	6 K		
14	8k		
15	10k		

MODEL GRAPH:



EX.NO:2(c)	DESIGN OF BAND PASS FILTER
DATE:	

AIM:

To design an active first order Butterworth type Band-pass filter with cut off frequency (f_c) between 1 KHz and 5 KHz.

DESIGN:

Design of a band pass filter with the upper cut-off frequency of 5 kHz and lower cut-off frequency 1kHz using IC741.

f_L for high pass filter - 1 KHz

f_L= 1 kHz

Assume C=0.01μf, R=?

$$f_L = \frac{1}{2\pi RC}$$

$$1\text{ KHz} = \frac{1}{2\pi \times 0.01 \times 10^{-6} \times R}$$

$$\boxed{R = 15.9K\Omega}$$

f_H for low pass filter - 5 kHz

$$f_H = \frac{1}{2\pi RC}$$

Assume C=0.01μf, R=?

$$5\text{ KHz} = \frac{1}{2\pi \times 0.01 \times 10^{-6} \times R}$$

$$\boxed{R = 3.19K\Omega}$$

Overall gain of the first order band pass filter is given by,

For High pass filter

A_{02}= 1+R_f/R1

A_{01}= 1+10 /10

A_{01} = 2

For low pass filter

A_{01}= 1+R_f / R1

A_{02} = 1+10/10

A_{02} = 2

$A_0 = A_{01} + A_{02} = 4$

Band width = $f_H - f_L$

BW = 5 KHz – 1KHz

BW = 4 kHz

Q = $\frac{f_0}{BW}$

$f_0 = \sqrt{f_H f_L} = \sqrt{5} = 2.236$

Q = $\frac{2.236}{4}$

Q = 0.55

Q factor is less than 10, so it is a wide band pass filter.

APPARATUS REQUIRED:

1. IC741 - 2 Nos
2. Capacitors (0.01μf - 2 Nos)
3. Resistors (10K - 4 Nos, 3.3K, 15.9K - each 1No.)
4. Connecting wires and Bread Board
5. CRO and AFO

THEORY:

A band pass filter has a pass band between two cut off frequencies such that $f_H > f_L$. Basically there are two types of band pass filters,

1) Wide band pass filter
2) Narrow band pass filter

If the Q factor is less than 10 it is a wide band pass filter. If the Q factor is greater than 10 it is a narrow band pass filter. Q factor is a measure of selectivity, meaning the higher value of Q, the more selective is the filter or the narrow its bandwidth (BW). The relationship between Q, BW and the center frequency f_c is given by

Q = $\frac{f_C}{BW} = \frac{f_C}{f_H - f_L}$; $f_C = \sqrt{f_H f_L}$

A wide band pass filter can be formed by cascading high pass and low pass filtering sections. To obtain a +/- 20dB / decade band pass, first order high pass and first order low pass sections are cascaded. For a +/- 40dB /decade band pass filter, second order high pass and second order low pass sections are connected in series, and so on. In other words the gain of the band pass filter depends on the order of the high pass and low passes filter sections.

PROCEDURE:

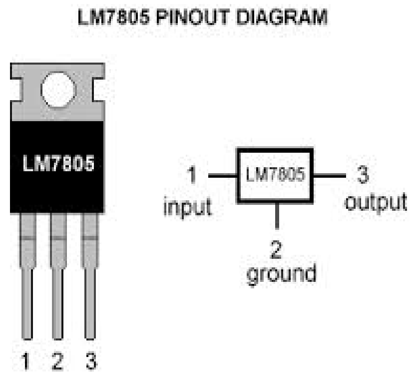
1. Connections are made as per the diagram.
2. The input voltage V_{in} is given, keeping it constant the input frequency is varied from 200 Hz to maximum frequency (10 KHz) and the output voltage is noted down.
3. The gain is calculated by using the formula 20 $\log_{10} V_0 / V_{in}$
4. The 3 dB line is drawn and the cut off frequency f_c is found. This is compared with theoretical value.

RESULT:

Thus the first order Band pass filter was designed and the cut-off frequency was calculated from the graph.

EXERCISE:

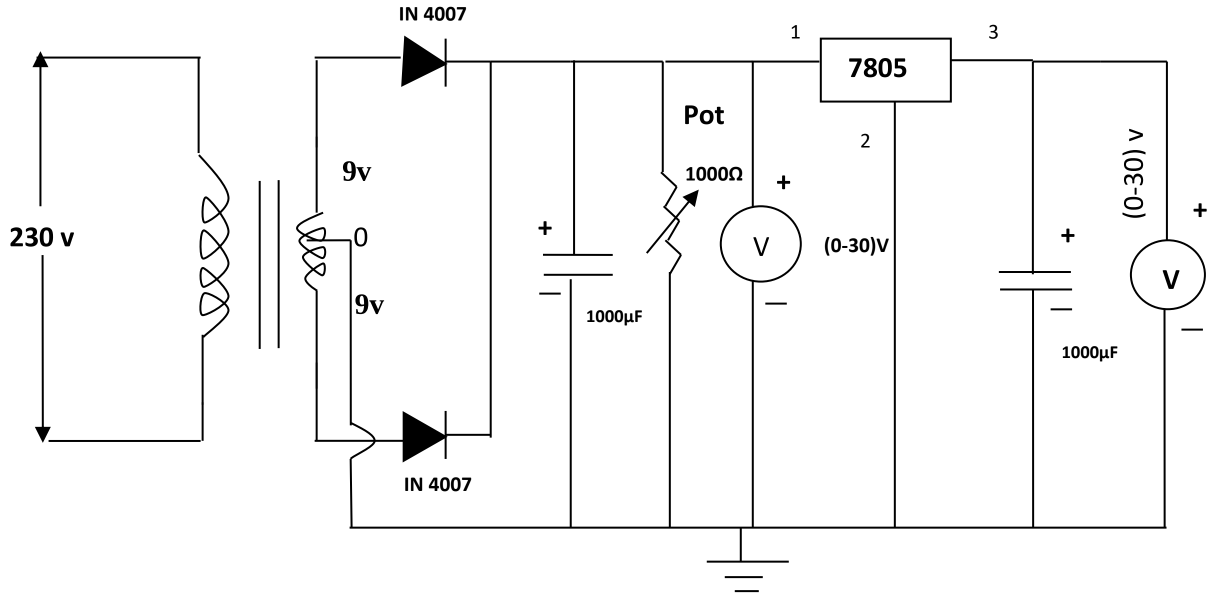
1. To design an active first order Butterworth type Band-pass filter with cut off frequency (f_c) between 2 KHz and 6 KHz.
2. To design an active first order Butterworth type Band-pass filter with cut off frequency (f_c) between 3 KHz and 6 KHz.
3. To design an active first order Butterworth type Band-pass filter with cut off frequency (f_c) between 2 KHz and 7 KHz.



Pin No	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

CIRCUIT DIAGRAM:

LINE REGULATION



TABULATION AND MODEL GRAPH:

LINE REGULATION

Input Voltage V_{in} (V)	Output Voltage V_{out} (V)

EX.NO:3(a)	DESIGN OF REGULATED POWER SUPPLY
DATE:	

AIM:

To design a Regulated Power Supply.

APPARATUS REQUIRED:

1. Diodes IN4007
2. Capacitors (100µF, 10µF – each 1 No.)
3. IC 7805
4. Potentiometer (1K)
5. Ammeter and Voltmeter

THEORY:

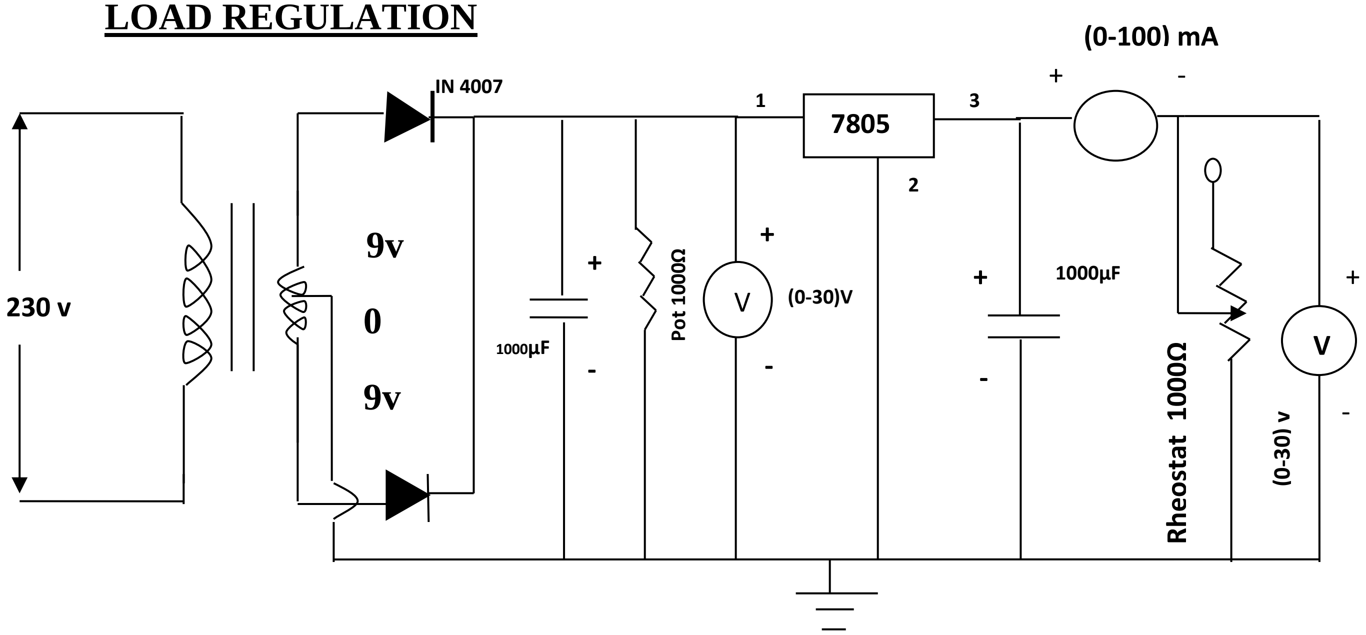
In an unregulated power supply, the o/p voltage changes whenever the i/p voltage (or) load changes. An ideal regulated power supply is an electronic circuit designed to provide predetermined DC voltage V_0 which is independent of the load current and variations in the input voltage. A voltage regulator is an electronic circuit that provides a stable DC voltage independent of the load current, temperature and AC line voltage variations. Although voltage regulators can be designed using op-amps, it is quicker and easier to use IC voltage regulators. Furthermore, the IC voltage regulators are versatile, relatively inexpensive and are available with features such as programmable o/p, current/voltage boosting and floating operation for high voltage application.

Some important types of linear IC voltage regulators are,

1. Fixed positive/negative o/p voltage regulators.
2. Adjustable o/p voltage regulators.

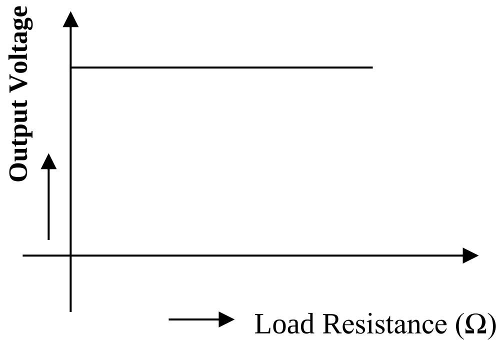
Fixed voltage regulators: 78XX series are three terminal, positive fixed voltage regulators. There are seven o/p voltage options available such as 5, 6, 8,12,15,18 and 24V. In 78XX, the last two numbers (XX) indicate the o/p voltage. 79XX series are negative fixed voltage regulators which are complements to the 78XX series devices. There are two extra voltage options of -2V and -5.2V available in 79XX series. The input capacitor used to eliminate the unwanted ripples present in the input and the output capacitor is used to eliminate oscillations because more oscillations present in the input.

LOAD REGULATION



TABULATION AND MODEL GRAPH:

Resistance (KΩ)	Current (mA)	Output Voltage (V)



A change in the input voltage to a Regulator does cause a change in its output voltage. The line Regulation rating of a voltage regulator indicates the change in the input voltage.

The line regulation of a voltage regulator is found as

$$\text{Line Regulation} = \frac{\Delta V out}{\Delta V in}$$

Where,

ΔV_{out} = the change in output voltage (usually in microvolt's (or) millivolts)

ΔV_{in} = the change in input voltage (usually in volts)

LOAD REGULATION

The Load Regulation means the change in regulator output voltage that occurs per unit change in load current.

The load regulation of a voltage regulator is found as,

$$\text{Load Regulation} = \frac{(V_{NL} - V_{FL})}{\Delta I_L}$$

Where,

V_{NL} is the no load output voltage (the output voltage when the load is open)

V_{FL} is the full load output voltage (the output voltage when the load is connected)

ΔIL is the change in load current,

Another way of expressing is this

$$\text{Load regulation} = \frac{\Delta \text{Vout}}{\Delta I_L}$$

PROCEDURE:

LINE REGULATION

1. Connections are made as per the circuit diagram.
2. Varying the input voltage from (0-15) v.
3. Note down the output voltage.
4. Draw the graph of line voltage Vs o/p voltage.

LOAD REGULATION

1. Connect a Variable Potentiometer across the output of the RPS.
2. Vary the Potentiometer from 100 Ω to 1KΩ and note down the corresponding output current and voltage.
3. Draw the graph of current Vs output voltage.

RESULT:

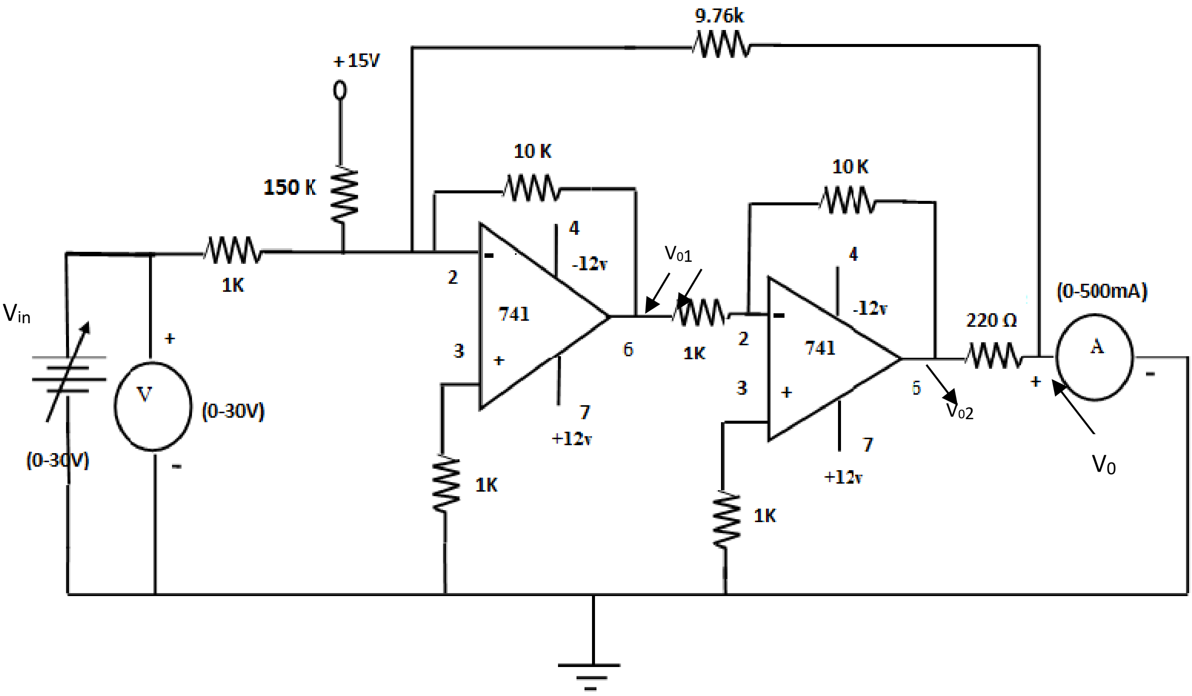
Thus the Load and Line Regulation was performed using regulated IC's.

EXERCISE:

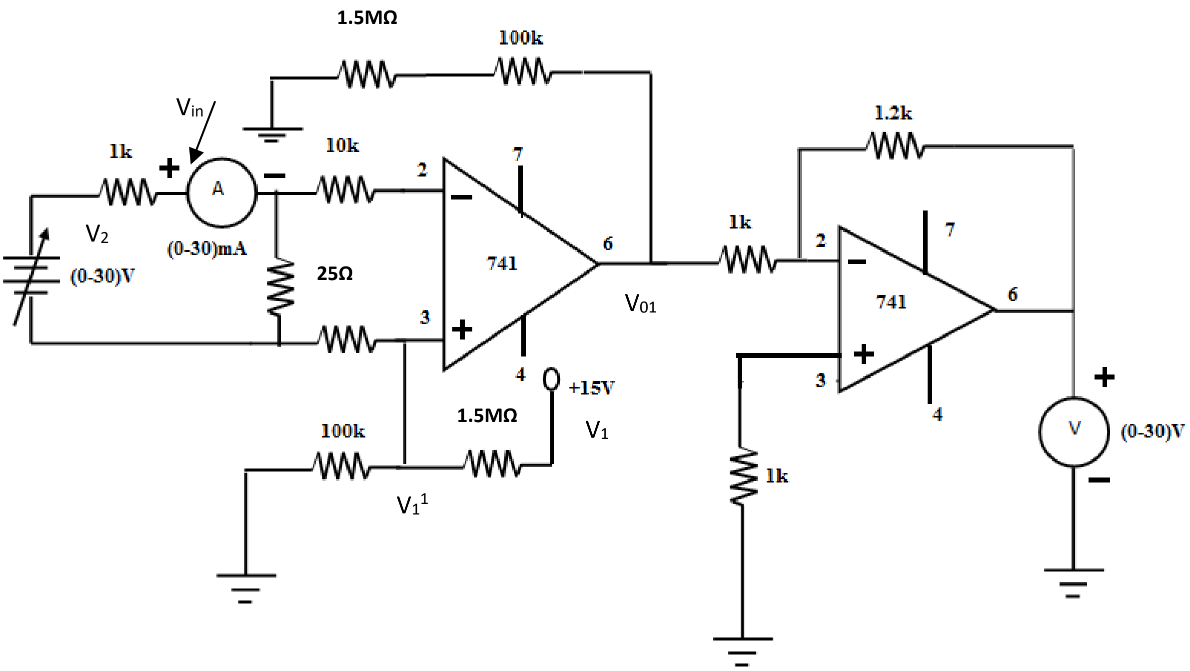
1. To design a Regulated Power Supply Using IC 7812 and 7912.
2. To design a Regulated Power Supply Using IC
3. To design a Regulated Power Supply Using Diodes.

CIRCUIT DIAGRAM:

V/I CONVERTER



I/V CONVERTER



EX.NO:3(b)	DESIGN OF V/I AND I/V CONVERTERS
DATE:	

AIM:

To design and verify the characteristics of voltage to current converter and current converter experimentally.

DESIGN:

CIRCUIT ANLAYSIS FOR VOLTAGE TO CURRENT CONVERTER

Apply KCL in node 1

$$\frac{15}{150}+\frac{v_{in}}{12.5}+\frac{v_{01}}{10}+\frac{v_0}{9.76}=0$$

If V_{01} is + Ve then V_{02} is –Ve ($V_{01} = -V_{02}$)

$$\frac{15}{150}+\frac{v_{in}}{12.5}+\frac{v_0}{9.76}=\frac{V_{02}}{10}$$

$0.1+0.08v_{in}+0.10245v_0=\frac{V_{02}}{10}$

$1+0.80v_{in}+1.0245v_0= V_{02}$

$V_{02}=1+0.80v_{in}+1.0245v_0$ ----1

Apply KCL in node 2

$$I_0=\frac{V_{02}-V_0}{0.249}-\frac{V_0}{9.76} \quad \text{----2}$$

Substitute 1 in 2

$$=\frac{1+0.80v_{in}+1.0245v_0-v_0}{0.249}-\frac{V_0}{9.76}$$

$$=\frac{9.76+7.8v_{in}+9.99v_0-9.76v_0-0.249v_0}{2.43}$$

$= 4.016+3.2v_{in}+4.11v_0-4.016v_0-0.10v_0$

$I_0= 4.016+3.2v_{in}+0.008v_0$ (V_0 is small value so neglect V_0)

When V_{in} = 0V

I_0= 4.016mA

When V_{in} = 5V

I_0= 20.016 mA

CIRCUIT ANALYSIS FOR CURRENT TO VOLTAGE CONVERTER:

Evaluation of V_{01} due to V_1

$V_{01} = \left[1 + \frac{100k}{1500k}\right] V_1^1$

$V_1^1 = \left[\frac{100k}{100K + 1500k}\right] 15v$

$= 0.9375v$

$= \left[1 + \frac{100k}{1500k}\right] (0.9375V)$

$V_{01(V1)} = 1V$

Evaluation of V_{01} due to V_2

$V_{01(V2)} = \left[-\frac{Rf}{Rin}\right] Vin = \left[\frac{-100k}{10k}\right] V_{in} = -10\ V_{in}$

$V_{01}(total) = V_{01(V1)} + V_{01(V2)}$

$V_{01} = 1\text{-}10\ Vin$

When ,

I_{in} = 4mA, V_{in} = 4mA x 25 Ω = 0.1 V, V_{01} = 1-10(0.1) = 0

I_{in} = 20mA, V_{in} = 20mA x 25 Ω = 0.5 V, V_{01} = 1-10(0.5) = -4

($V_{in} = I_{in}$ x R; R = 25Ω)

Second stage amplification factor

$V_0 = \left(\frac{-Rf}{Rin}\right) V_{01} = \left(\frac{-1.2k}{1k}\right) V_{01}$

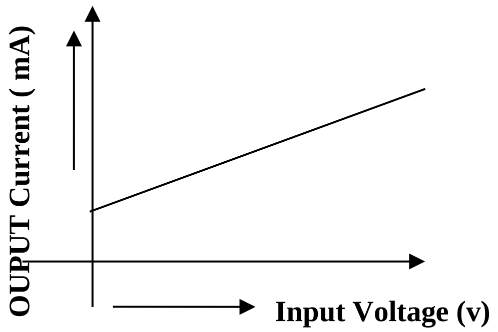
V_o (when I = 4mA) = (-1.2) (0) = 0 volt

V_o (when I = 20mA) = (-1.2) (-4) = 4.8volt

TABULATION AND MODEL GRAPH:

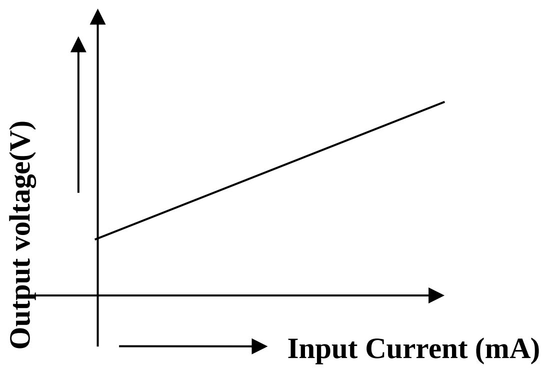
V/I CONVERTER

Input voltage (V)	Output Current (mA)



I/V CONVERTER

Input Current (mA)	Output voltage (V)



APPARATUS REQUIRED:

1. IC 741 – 2Nos.
2. Power supply (0-30) V
3. Power supply +/- 12V
4. Resistors (10K,150K,10K,4.7K – each 1 No.)
5. Ammeter (0-30) mA
6. Multimeter

THEORY:

The active current-to-voltage converter is an amplifier with current input and voltage output. The current-to-voltage converter provides an output voltage that is directly proportional to input current and vice versa.

PROCEDURE:

1. Connections are made as per the diagram.
2. By varying the voltage using the power supply corresponding current values in the ammeter are noted.
3. Plot the graph for voltage Vs current.
4. For current to voltage converter initially set the current values in the ammeter and take the voltage using the voltmeter.
5. Plot the graph for current Vs voltage

RESULT:

Thus V/I and I/V converters are designed and their characteristics were obtained.

EX.NO:4	DESIGN OF LINEARIZING CIRCUITS AND COLD–JUNCTION COMPENSATION CIRCUIT FOR THERMOCOUPLES
DATE:	

AIM:

To design and implement the cold-junction compensation circuit for Thermocouple with the following specifications. When the Hot junction temp is 100 °C and reference junction temp is 30 °C the output should be 0V and hot junction maintain 100 °C and reference junction reaches 50 °C the output should be 2 V.

DESIGN FOR COLD JUNCTION COMPENSATION,

RTD – PT -100

$R_{RTD} = R_o (1+ \propto t)$

R_o = RTD resistance at 0°C =100Ω

$\propto$ = Temperature co-efficient ($\propto$=0.0039/° C)

$R_{30°C} = 100\,[1+ 0.0039\,(30)] = 111.7\ \Omega.$

$R_{100°c} = 100[1+ 0.0039(100)] = 139\ \Omega.$

Maximum current through RTD not exceeds 0.01469 A

Find voltage across RTD

$V_{RTD} = I\,R_{RTD}\,, = 0.01469A * 139\ \Omega = 2.0419v.$

Choose V_{in} = 5volts.

Find R_2

$V_{in} = V_{R2} + V_{RTD}$

$= IR_2 + V_{RTD}$

$5V = 0.01469A, R_2 + 2.0419V$

R_2 = 201.3 Ω. Let us use 220 Ω (standard value) for R_2, $R_2 = R_1 = 220\ \Omega$

To null the bridge at 30°C

$$\Delta V = \left[\frac{Rrtd}{Rrtd+R2} - \frac{R3}{R3+R1}\right] x\ V_{in,} = \left[\frac{111.7}{111.7+220} - \frac{111.7}{111.7+220}\right](5v) = 0\ V$$

Output of the bridge circuit at 100°C

$$\Delta V = \left[\frac{139}{139+220} - \frac{111.7}{111.7+220}\right](5v) = 0.2594\ v$$

Differential Amplifier Stage

$V = (Va – Vb)\, R_5/R_4$

V = 0.2594 v

Non Inverting Summer stage:

Vo = $\left(1+\frac{Rf}{R}\right)\left(\frac{(Va+Vb)}{2}\right)$--------- 1

Vo = 2v,Assume R=1kΩ

Va = 3mV , Vb = 0.252V

To find Rf , Apply this value in Eqn 1

2v = $\left(1+\frac{Rf}{1}\right)\frac{(3\ X\ 10^{-3}+0.252)}{2}$

4= (1+Rf) (0.003+0.252)

4 = 0.255+.255Rf

Rf= 14.68 ≈ 15kΩ.

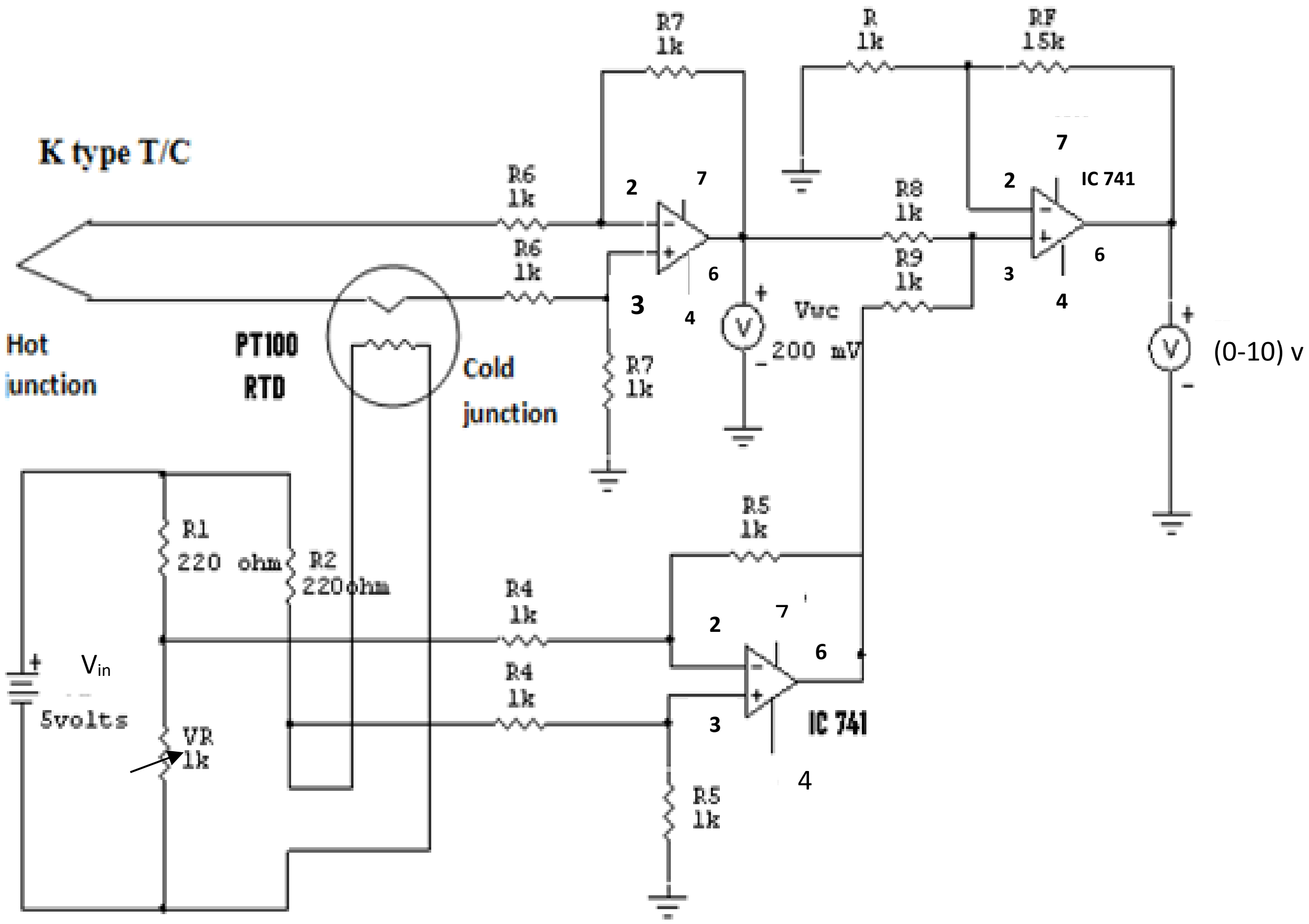
APPARATUS REQUIRED:

1. T/C – K type
2. RTD- PT -100
3. Resistors (15K,1K -12No., 220 Ω – 2No.)
4. Variable resistor -1K – 1No.
5. Multimeter – 2
6. Op Amp – 741- 3
7. Connecting wires and bread board.

THEORY:

Reference junction compensation: A problem with the practical use of T/C is the necessity of knowing the reference temperature. Because the T/C voltage is proportional to the difference between the measurement and reference junction temperatures, variations of the reference show up as direct errors in the measurement temperature determination. A factor which is important in the use of T/C is the requirement of a known reference junction. This is because when the reference junction is not held at 0°C, the observed value must be corrected by adding to it a voltage that has resulted from a temperature difference equal to the amount by which the reference junction is above 0° C. (This is because the T/C are calibrated with temperature of reference junction as 0°C). Now $E_T = E_t + E_0$ where E_T is the total emf at temperature T, E_t is the emf on account of temperature difference between detecting (hot) and the reference junction and E_0 is the emf due to temperature of the reference junction being above 0°C. Since, there exists a nonlinear relationship between the emf and the temperature, it is important that temperatures are determined by the above process rather than converting an emf to temperature and then adding it to ambient temperature.

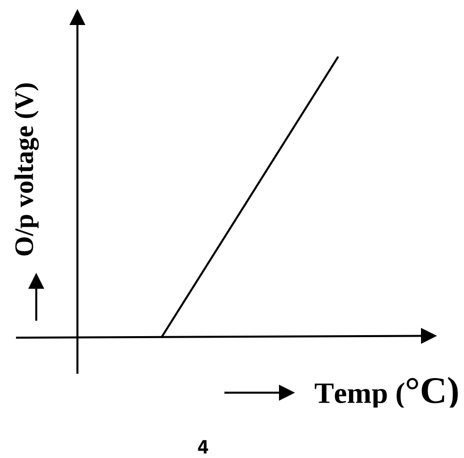
CIRCUIT DIAGRAM:



TABULAR COLUMN:

MODEL GRAPH

With cold junction compensation	
Temperature in°(c)	O/p in Voltage (V)



PROCEDURE:

1.Connections are made as per the circuit diagram.
2. Switch on the heater upto 100 ° C.
3. Notedown the temperature and without compensation o/p voltage readings up to100°C .
4. Maintain T/C hot junction temp. 100° C constantly.
5. Now switch on the RTD inseterd heater.
6. Note down the cold junction temp and output voltage readings until the temp reaches upto 100° C .
7. Plot the graph for cold junction temp and output voltage.

RESULT:

Thus the cold junction compensation circuit was designed and implemented for the given specification. And also plot the graph of temperature Vs O/p voltage.

EX.NO:5(a)	DESIGN OF SIGNAL CONDITIONING CIRCUIT FOR STRAIN GAUGE
DATE:	

AIM:

To design a signal conditioning circuit for strain gauge for 2V.

DESIGN

GAUGE FACTOR= $\frac{\frac{\Delta R}{R}}{\frac{\Delta L}{L}}$

Gauge Factor for the Foil Type Strain Gauge =2

$\Delta E_O = \frac{\Delta R}{R} e_i$

ΔE_O = Bridge output voltage

e_i = bridge I/P voltage (source voltage)

R=350Ω (Foil type Bonded)

APPARATUS REQUIRED:

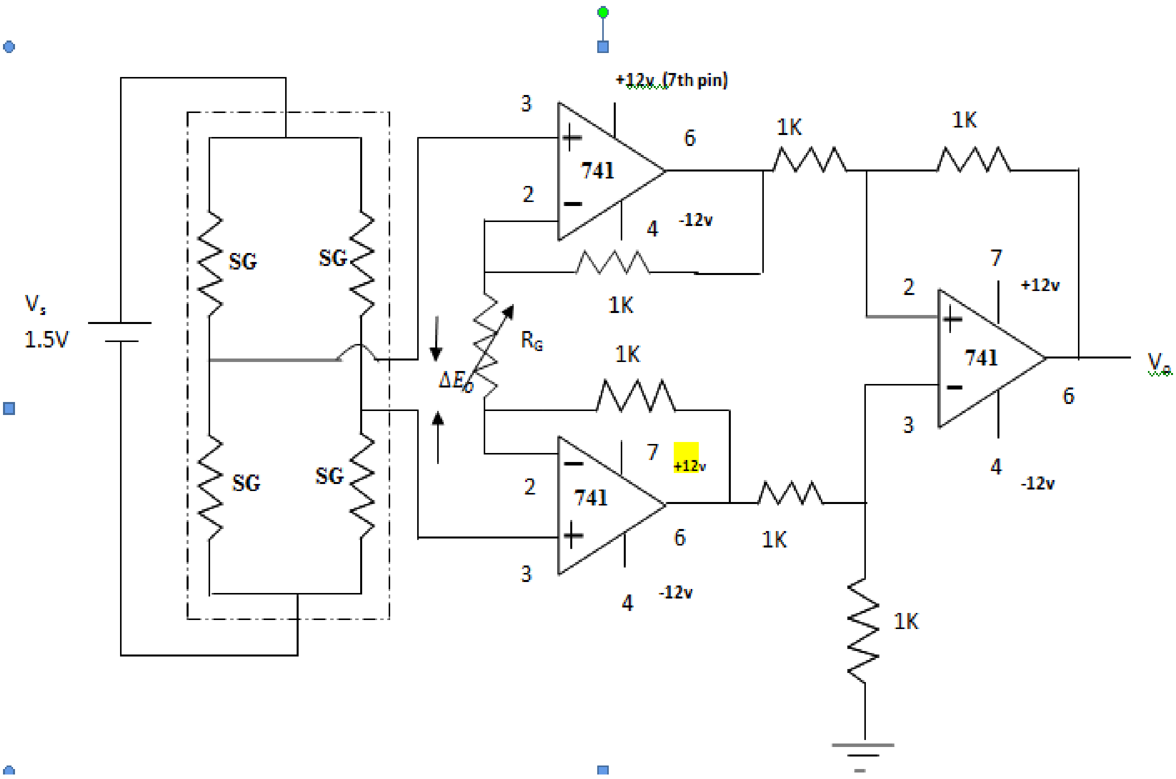
1. Strain gauge trainer kit
2. Multimeter-2
3. Bread board and connecting wires.
4. Power supply-(0-12)v
5. Op-amp-3
6. Resistor-1kΩ

THEORY:

A strain gauge (also strain gage) is a device used to measure the strain of an object. Strain is the amount of deformation of a body due to an applied force. More specifically, strain (e) is defined as the frictional change in length. While there are several methods of measuring strain, the most common is wit h a strain gauge, a device whose electrical resistance varies in proportion to the amount of strain in the device. For example, the piezo resistive strain gauge is a semiconductor device whose resistance varies non linearly with strain. The most widely used gauge, however, is the bonded metallic strain gauge consists of a fine wire or, most commonly, metallic foil arranged in a grid pattern.

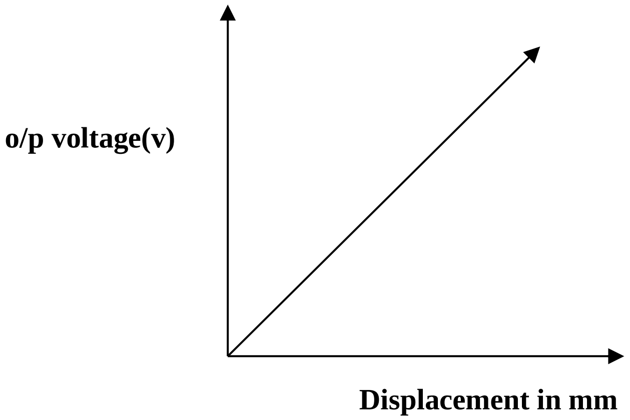
Strain gauge measurement involves sensing extremely small changes in resistance. Therefore, proper selection and use of bridge signal conditioning, wiring, and data acquisition components are required for reliable measurements. A strain gauge sensor has four active gauges, to complete the bridge with reference resistors.

CIRCUIT DIAGRAM



STRAIN GAUGE=350Ω Bonded Foil Type

Model graph:



Tabulation:

S.No	Weight in kg	Bridge O/P (mV) (practical)	Amplified O/P (V)
1	200		
2	400		
3	600		
4	800		
5	1000		

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Switch on the strain gauge trainer kit.
3. Place the weight in a cantilever beam from 200-1000gm.
4. Observe the bridge output voltage.
5. The bridge output is given to an instrumentation amplifier and the amplified output is obtained.
6. The graph is plotted between the weight and o/p voltage.

RESULT:

Thus the signal conditioning circuit for strain gauge was designed and the characteristics are obtained.

EX.NO:5(b)	**DESIGN OF SIGNAL CONDITIONING CIRCUIT FOR RTD**
DATE:	

AIM

To design a signal conditioning circuit for RTD with following specifications.

Temperature range: 30ºC-100ºC

Output voltage range: 0-5V (DC).

Sensor: RTD (Pt 100).

Current through RTD: Not to exceed 0.01469A

DESIGN

RTD - Pt-100

$R_{RTD} = R_o (1+ \propto t)$

R_o = RTD resistance at 0°C =100Ω

$\propto$ = Temperature co-efficient ($\propto$=0.0039/°c)

$R_{30°c}$ = 100 [1+ 0.0039 (30)] = 111.7 Ω.

$R_{100°c}$ = 100[1+ 0.0039(100)] = 139 Ω.

Find voltage across RTD

$V_{RTD} = I R_{RTD}$, = 0.01469A * 139 Ω = 2.0419v.

Choose V_{in} = 5volts.

Find R_2

$V_{in} = V_{R2} + V_{RTD}$

$= IR_2 + V_{RTD}$

$5V = 0.01469 R_2 + 2.0419V$

R_2 = 201.3 Ω. Let us use 220 Ω (standard value) for R_2, $R_2 = R_1$ = 220 Ω.

To null the bridge at 30°c

$$\Delta V = \left[\frac{R3}{R3+R1} - \frac{\text{Rrtd}}{\text{Rrtd}+R2}\right] \times V_{in}, = \left[\frac{111.7}{111.7+220} - \frac{111.7}{111.7+220}\right] \times 5v = 0\ V$$

Output of the bridge circuit at 100°c

$$\Delta V = \left[\frac{111.7}{111.7+220} - \frac{139}{139+220}\right] \times 5v$$

$= -0.2594$ V

<u>Differential amplifier stage</u>

$V = (Va - Vb)\, R_5/R_4$
$V = -0.2594$ V

<u>Inverting amplifier stage</u>

$V_o = -\frac{Rf}{Rin}(V_{in})$

$5v = -\frac{Rf}{Rin}(-0.2594v)$

Assume $R_{in} = 1k\ \Omega$

$R_f = 19.2k\ \Omega$.

30mW/°C.

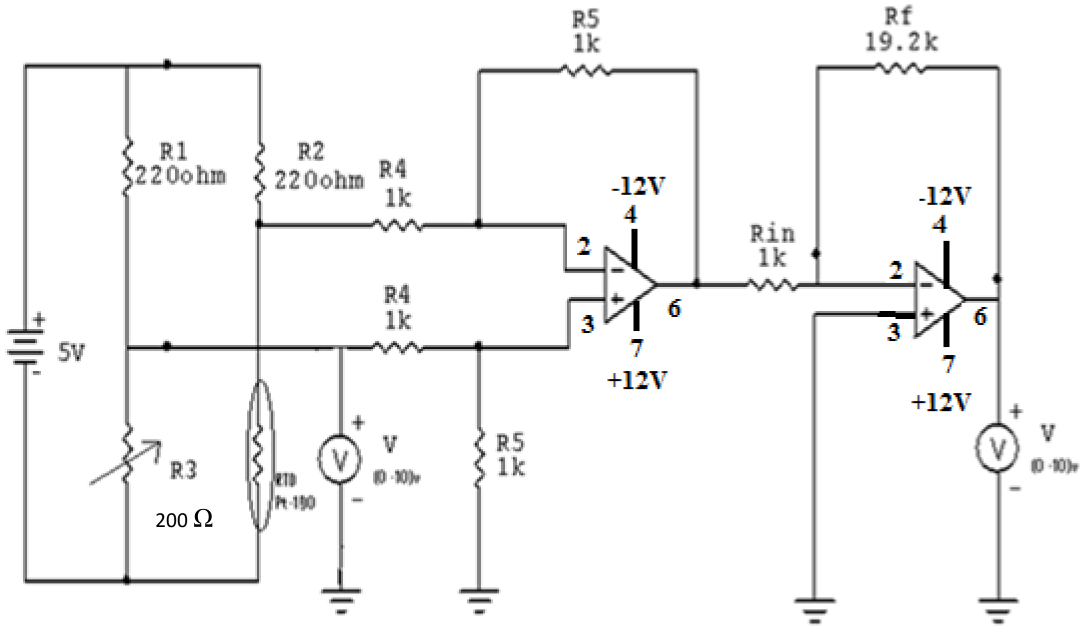
APPARATUS REQUIRED

1. Op-amp-2 No's (IC 741)
2. Resistors-- 220Ω-4, 1k-5,19.2k-1
3. Variable resistor (1K) -1
4. Power supply 0-30v,+/-12v
5. Voltmeter (0-30)v
6. Bread board and connecting wires.

THEORY

Water flows through a pipe which is immersed in another hot liquid, a control systems is to regulate the water temperature by controlling the flow. For this purpose it is required to measure the temperature in range from 30°c to 100°c using RTD.A control system will regulate the water temperature so a measurement must be provided to convert 30°c to 100 °c into 0 to 5 volts using Pt – 100.The error due to self heating of the RTD should not exceed 1°c.Power dissipation constant (P_D) of RTD is 30 mW/°c.

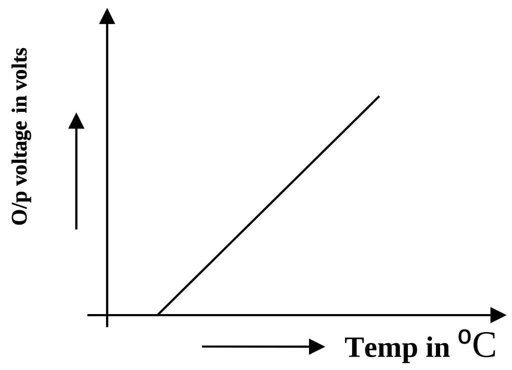
CIRCUIT DIAGRAM:



TABULAR COLUMN

S.No	Temperature in °C	Output voltage in volts

MODEL GRAPH



PROCEDURE

1. Connections are made as per the circuit diagram.
2. Note down the o/p voltage of 0v at 30°C.
3. Note down the bridge o/p voltage and amplifier o/p voltage for every 10°C rise in temperature.
4. Plot the graph for temp Vs o/p voltage.

RESULT

Thus the signal conditioning circuit for RTD is designed and implemented.

EX.NO:6	DESIGN OF ORIFICE PLATE AND ROTAMETER
DATE:	

AIM:

(a) To design the Orifice plate for the given specification.
(b) To design a Rotameter for the given specification

DESIGN :

Orifice

Tank diameter=240mm

Pipe diameter=19mm

Lph =?

Pressure head difference =?

Cd=0.62 (constant)

H=10cm

t=?

g (acceleration due to gravity)=9.8m/s^2

$A=\pi d^2/4$

$Cd=Q_{ac\,t} / Q_{th}$

$Q_{act} = Ah/t$ m^3/s

$a_1\, a_2 \sqrt{2gH} / \sqrt{a_1^2\, a_2^2}$ m^3/s

d_2=?

Rotameter

Tank Diameter – 240mm

Tank height -10cm-100mm

$Q_{act} = \frac{Ah}{t}$ m^3/s

$Q_{th} = \frac{Lph \ x \ 10^{-3}}{3600}$ m^3/s

$C_d = \frac{\text{Qact}}{\text{Qtht}}$

% of Error = $\frac{\text{Qth}-\text{Qact}}{\text{Qtht}}$

Area of the Tank =

$\frac{\pi D^2}{4} = \frac{3.14 \text{ x } 240 \text{ x } 240 \text{ x} 10^{-3} \text{ x } 10^{-3}}{4}$

Area (A) =?

b) DESIGN OF ROTAMETER

(i) To design a tapered angle 'α' of a rotameter using the given specifications.

(ii) To calculate discharge coefficient, Cd and %error for the given rotameter.

SPECIFICATIONS:

Flow rate,Q=400lph

Height of the float from inlet y=6.5cm

Diameter of the inlet (D)=diameter of the float d=0.8cm

Drag coefficient, Cd =0.4

Density of the fluid (water)ρ_f = 1000kg/m^3

Density of the float (bob) ρ_b =3000kg/m^3

Volume of the float V_b = 5 ml of liquid

Diameter of the collecting tank, D1 =240mm

DESIGN

To design for taper angle 'α'of the given rotameter

The constant mean velocity,V_m is given by,

$V_m = \sqrt{\frac{2V_b g}{C_D \ S_b} \frac{(\rho_{b-}\rho_{f)}}{\rho_{f)}}}$

Where S_b is the frontal area of the bob

$S_b = \frac{\pi}{4}(d^2)$

The available area for flow, A_f is given by,

$A_f = \frac{\pi}{4}[(D+2y\tan\alpha)^2 - d^2]$

$= \frac{\pi}{4}[(D^2-d^2+ 4yD\tan\alpha)^2 - d^2]$

$= \frac{\pi}{4}[D^2-d^2] + \pi.yD\tan\alpha$

If D=d, then $A_f = \pi\, yD\tan\alpha$

The volume flow rate through a rotameter is given by,

$$Q=V_m .A_f = \sqrt{\frac{2V_b g}{C_D\, S_b}\frac{(\rho_b-\rho_f)}{\rho_f)}}\,.\,\pi\, yD\tan\alpha$$

$$\text{(or) } Q=K.Y, \text{where } K=\sqrt{\frac{2V_b g}{C_D\, S_b}\frac{(\rho_b-\rho_f)}{\rho_f)}}\,.\,\pi\, D\tan\alpha$$

APPARATUS REQUIRED:

1. Pump and reservoir.
2. Pipeline with orifice plate and rotameter
3. Collecting tank.
4. Vfmt-03 trainer kit
5. Stop watch

THEORY

An **orifice plate** is a device used for measuring flow rate, for reducing pressure or for restricting flow (in the latter two cases it is often called a *restriction plate*). Either a volumetric or mass flow rate may be determined, depending on the calculation associated with the orifice plate. It uses the same principle as a Venturi nozzle, namely Bernoulli's principle which states that there is a relationship between the pressure of the fluid and the velocity of the fluid. When the velocity increases, the pressure decreases and vice versa.

An orifice plate is a thin plate with a hole in it, which is usually placed in a pipe. When a fluid (whether liquid or gaseous) passes through the orifice, its pressure builds up slightly upstream of the orifice but as the fluid is forced to converge to pass through the hole, the velocity increases and the fluid pressure decreases. A little downstream of the orifice the flow reaches its point of maximum convergence, the *vena contracta* where the velocity reaches its maximum and the pressure reaches its minimum. Beyond that, the flow expands, the velocity falls and the pressure increases. By measuring the difference in fluid pressure across tappings upstream and downstream of the plate, the flow rate can be obtained from Bernoulli's equation using coefficients established from extensive research.

Orifice plates are most commonly used to measure flow rates in pipes, when the fluid is single-phase (rather than being a mixture of gases and liquids, or of liquids and solids) and well-mixed, the flow is continuous rather than pulsating, the fluid occupies the entire pipe (precluding silt or trapped gas), the flow profile is even and well-developed and the fluid and flow rate meet certain other conditions. Under these circumstances and when the orifice plate is constructed and installed according to appropriate standards, the flow rate can easily be determined using published formulae based on substantial research and published in industry, national and international standards.

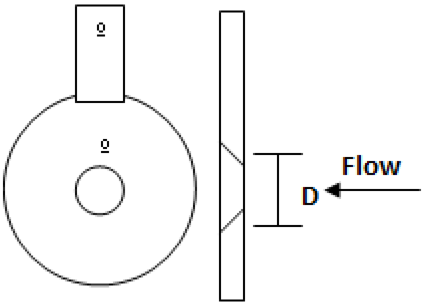
Plates are commonly made with sharp-edged circular orifices and installed concentric with the pipe and with pressure tappings at one of three standard pairs of distances upstream and downstream of the plate; these types are covered by ISO 5167 and other major standards. There are many other possibilities. The edges may be rounded or conical, the plate may have an orifice the same size as the pipe except for a segment at top or bottom which is obstructed, the orifice may be installed eccentric to the pipe, and the pressure tappings may be at other positions. Variations on these possibilities are covered in various standards and handbooks. Each combination gives rise to different coefficients of discharge which can be predicted so long as various conditions are met, conditions which differ from one type to another.

Once the orifice plate is designed and installed, the flow rate can often be indicated with an acceptably low uncertainty simply by taking the square root of the differential pressure across the orifice's pressure tappings and applying an appropriate constant. Even compressible flows of gases that vary in pressure and temperature may be measured with acceptable uncertainty by merely taking the square roots of the absolute pressure and/or temperature, depending on the purpose of the measurement and the costs of ancillary instrumentation.

The different types of orifice plates are:

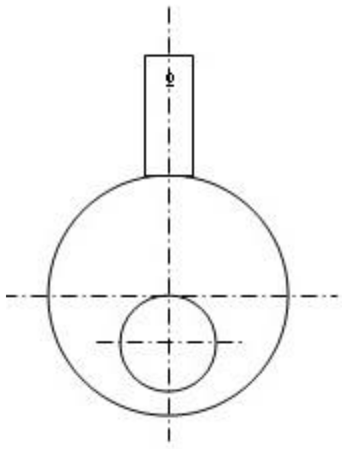
1. Concentric.
2. Segmental.
3. Eccentric.
4. Quadrant Edge.

Concentric: The concentric orifice plate is used for ideal liquid as well as gases and steam service. This orifice plate beta ratio fall between of 0.15 to 0.75 for liquid and 0.20 to 0.70 for gases, and steam. Best results occur between value of 0.4 and 0.6. Beta ratio of the orifice bore to the internal pipe diameters.



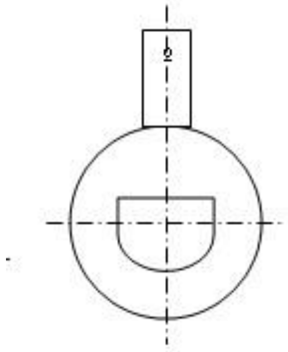
(45º beveled edges are often used to minimize friction resistance to flowing fluid.)

Eccentric: The eccentric orifice plate has a hole eccentric. Use full for measuring containing solids, oil containing water and wet steam. Eccentric plates can be used either flange or vena contracts taps, but the tap must be at 180º or 90º to the eccentric opening.
Eccentric orifices have the bore offset from center to minimize problems in services of solids-containing materials.



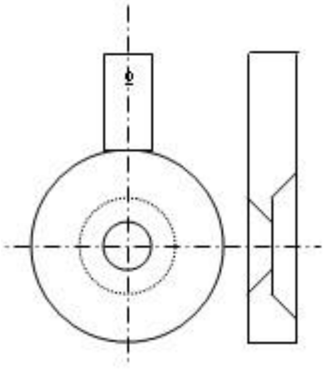
Segmental: The segmental orifice plate has the hole in the form segment of a circle. This is used for colloidal and slurry flow measurement. For best accuracy, the tap location should be 180º from center of tangency.

Segmental orifices provide another version of plates useful for solids containing materials.



Quadrant Edge: It common use in Europe and are particularly useful for pipe sizes less than 2 inches.

Quadrant edge orifices produce a relatively constant coefficient of discharge for services with low Reynolds numbers in the range from 100,000 down to 5,000.



ROTAMETER

A **rotameter** is a device that measures the flow rate of fluid in a closed tube.It belongs to a class of meters called variable area meters, which measure flow rate by allowing the cross-sectional area the fluid travels through, to vary, causing a measurable effect.

A rotameter consists of a tapered tube, typically made of glass with a 'float', made either of anodized aluminum or a ceramic, actually a shaped weight, inside that is pushed up by the drag force of the flow and pulled down by gravity. The drag force for a given fluid and float cross section is a function of flow speed squared only, see drag equation.

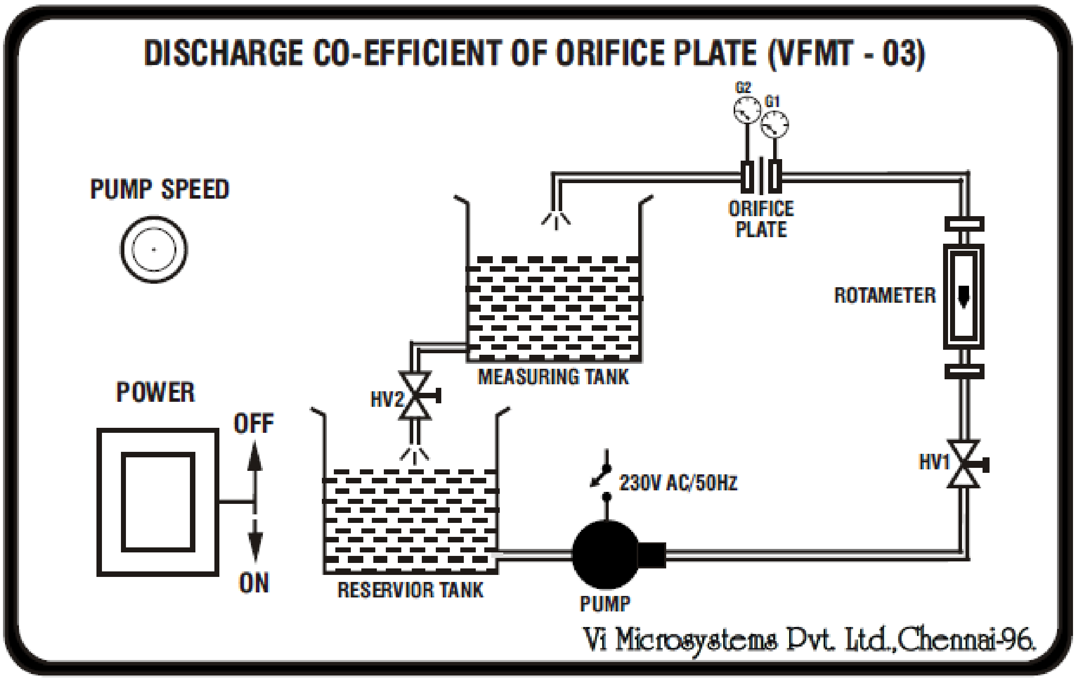
A higher volumetric flow rate through a given area increases flow speed and drag force, so the float will be pushed upwards. However, as the inside of the rotameter is cone shaped (widens), the area around the float through which the medium flows increases, the flow speed and drag force decrease until there is mechanical equilibrium with the float's weight.

Floats are made in many different shapes, with spheres and ellipsoids being the most common. The float may be diagonally grooved and partially colored so that it rotates axially as the fluid passes. This shows if the float is stuck since it will only rotate if it is free. Readings are usually taken at the top of the widest part of the float; the center for an ellipsoid, or the top for a cylinder. Some manufacturers use a different standard.

The "float" must not float in the fluid: it has to have a higher density than the fluid, otherwise it will float to the top even if there is no flow.

The mechanical nature of the measuring principle provides a flow measurement device that does not require any electrical power. If the tube is made of metal, the float position is transferred to an external indicator via a magnetic coupling. This capability has considerably expanded the range of applications for the variable area flowmeter, since the measurement can observed remotely from the process or used for automatic control.

FRONT PANEL DIAGRAM



TABULAR COLUMN:

Flow rate (LPH)	Pressure Head in mm of water column	Time(sec)

PROCEDURE:

Orifice & Rotameter

1. Switch on the pump.
2. Maintain the overhead tank level, by varying the pump speed.
3. Set the flow in the Rotameter 600 LPH.
4. Start the timer.
5. As the water level rises in the measuring tank, say 10 cm head, note down the time taken in the timer to reach the required head and pressure difference H in the pressure gauge.
6. Using the values, calculate the diameter of orifice and tapered angle α of rotameter.

RESULT:

Thus the bore diameter of orifice plate and α of rotameter was designed.

EX.NO:7	**DESIGN OF CONTROL VALVE (SIZING AND FLOW-LIFT CHARACTERISTICS)**
DATE:	

AIM:

To design a control valve size for the given specifications and obtain the flow lift characteristics for various control valve.

DESIGN:

For liquids

The valve flow coefficient is given by

$$C_v = Q\sqrt{\frac{SG}{\Delta P}}$$

Where, Q = flow rate in gallons per minute (gpm)

ΔP = pressure difference between inlet and outlet (psi)

From the table, SG=1

For sizing a water valve,

Valve coefficient, $C_v = Q \times \sqrt{\frac{1}{\Delta P}}$

Specifications:

Specific gravity of liquid (water) =1.0

(i) For equal percentage valve Q=450 LPH
(ii) For quick opening valve Q=600 LPH
(iii) For linear valve Q = 480 LPH

APPARATUS REQUIRED:

1. Control valve trainer setup with equal percentage, quick opening and linear control valves.
2. Air compressor.

THEORY:

The proper size of the control valve is important because of the effect on the operation of the automatic controller. If the control valve is over size, for example, the valve must operate at low lift and the minimum controllable flow is too large. In addition, the lower part of the flow lift characteristics is most likely to be no-uniform in shape. On the other hand if the control valve is under size, the maximum flow desired for the operation of a process may not be provided.

The flow of a liquid through a fully open control valve is assumed to be given by

$$M=K_a\sqrt{\frac{2g\Delta p}{\gamma}}$$

Where m=flow rate, ft3 /sec

K= flow co-efficient

A= area of port opening, ft^2

ΔP= pressure differential lb/ ft^2

γ = fluid density, lb/ ft^3

The flow co-coefficient K and port area a are different for every style or size of control valve. Consequently, it is standard practice to combine certain terms of the above equation in to a single number C_v , termed the size coefficient.

$$Q = C_v\sqrt{\frac{\Delta P}{G}}$$

Where Q, liquid flow rate in gallons per minute at the condition for which specific gravity G is taken

C_v = size coefficient

ΔP = pressure drop, lb/in^2

G = specific gravity of liquid (referred to water) at either flowing or standard conditions.

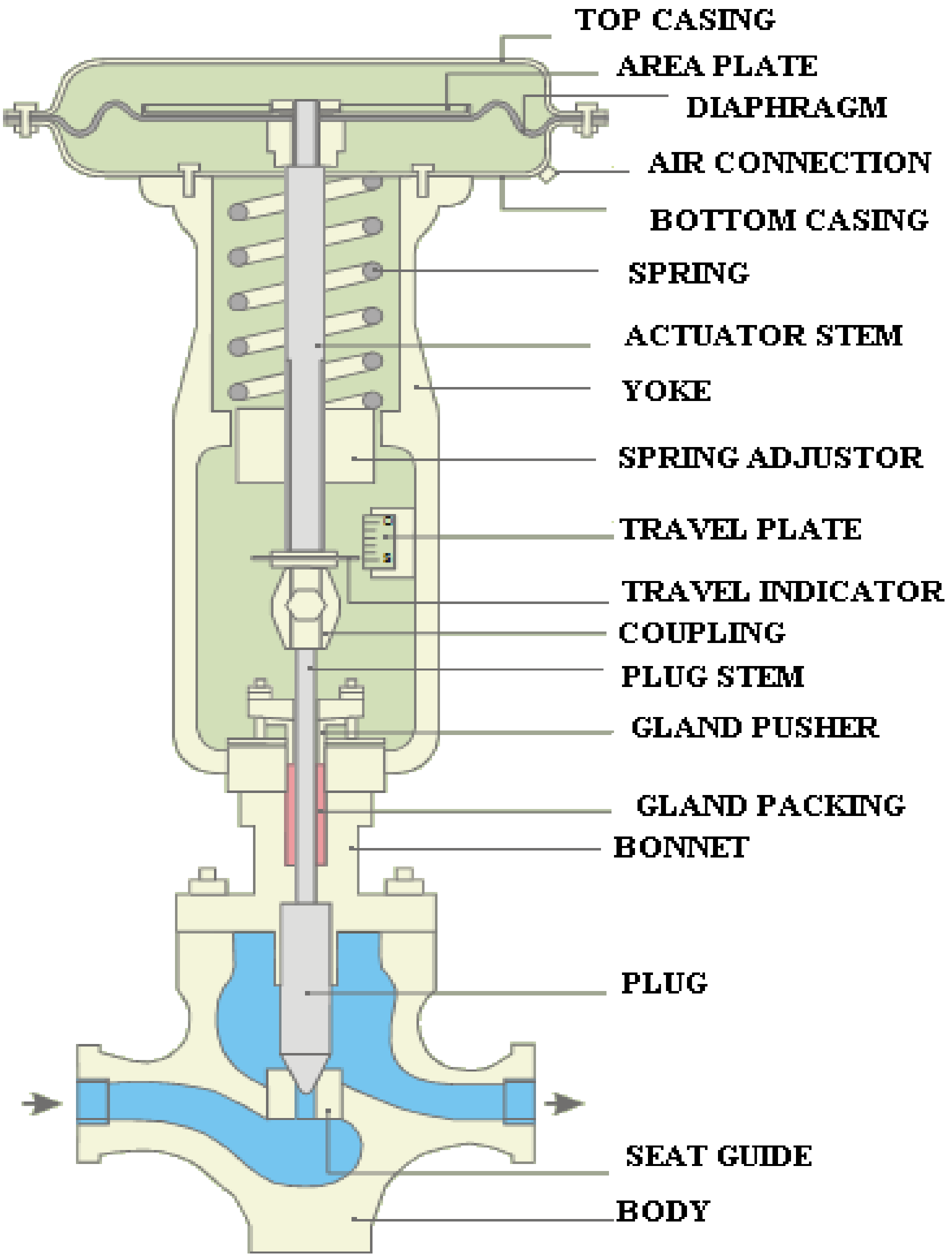
TABLES:

Valve size (inches)	C_v
¼	0.3
½	3
1	14
1 ½	35
2	55
3	108
4	174
6	400
8	725

SPECIFIC GRAVITY OF LIQUIDS

LIQUID	SG
Alcohol ,Methyl	0.79
Alcohol , ethyl	0.79
Ethylene glycol (50%)	1.07
Propylene glycol (50%)	1.04
Brine (10% by weight)	1.09
Brine (20% by weight)	1.85
Water	1.00

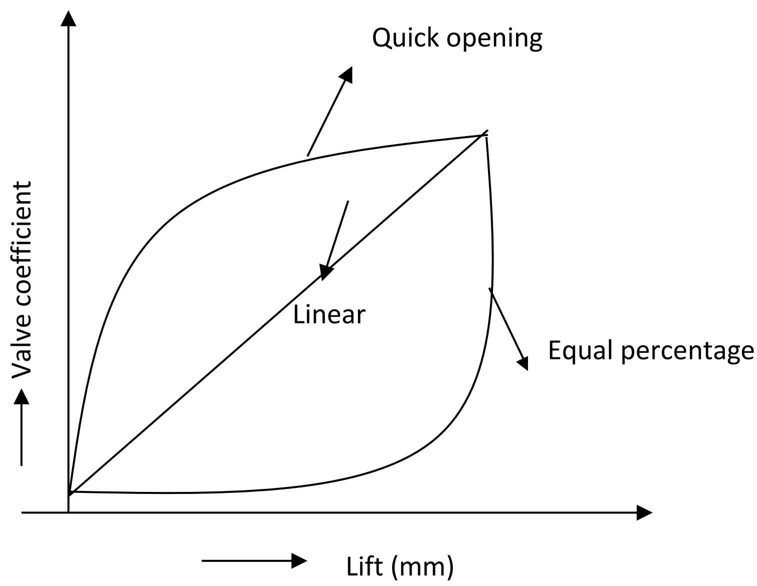
SPECIFIC GRAVITY OF GASES	
GAS	SG
Air	1.00
Carbon dioxide	1.52
Carbon monoxide	0.97
Oxygen	1.11
Water vapour	0.62
Ammonia	0.59



Control Valve (Air to Open)

TABULATION AND MODEL GRAPH:

Type of control valve	Flow rate (LPH)	Stem lift (x10^{-3})	Differential pressure (ΔP) mm of water column	Flow rate Q (gpm)=$Q_{LPH} \times \frac{0.264}{60}$	ΔP (psi) = ΔP (mm)x 0.0361	C_v
Equal percentage						
Quick opening						
linear						



PROCEDURE

1. Start the setup, open the flow regulating valve of the control valve to be studied.
2. Ensure that pressure regulator outlet is connected to the valve actuator of the control valve under study.
3. Keep the control valve fully open by adjusting air regulator.
4. Adjust regulating valve and set the flow rate.
5. Slowly increase or decrease air pressure by adjusting the regulator and close the control valve.
6. Note the pressure drop of control valve at fully open condition.
7. Repeat the above step for various flow rates and note down the readings.
8. Calculate the valve coefficient for various flow rates.
9. From the table, find out the valve size.
10. Draw the graph for stem lift vs. valve coefficient for various control valves.

RESULT

Thus the control valve size for the given specifications was determined and the Flow Lift characteristic was plotted.

EX.NO:8	DESIGN OF PID CONTROLLER
DATE:	

AIM:

To study the response of P, PI, PD, PID controllers using op amp IC741 and Microprocessor.

DESIGN:

For P controller

$G_P = \frac{R_2}{R_1}$

Assume $R_1 = 1k\Omega$

Given $G_P = 10$

$10 = \frac{R_2}{1k}$

$R_2 = 10\ k\Omega$

For I controller

$G_I = \frac{1}{R_I\ C_I}$

Given $G_I = 1000$

Assume $C_I = 0.1\mu F$

$1000 = \frac{1}{R_I X 0.1 X 10^{-6}}$

$R_I = \frac{1}{1000 X 0.1 X 10^{-6}} = 10K\Omega$

$R_I = 10K\Omega$

For D controller

$G_D = R_D C_D$

Given $G_D = 0.001s$

Assume $C_D = 0.1\mu F$

$0.001s = R_D \text{ x } 0.1 \text{x } 10^{-6}$

$R_D = \frac{0.001}{0.1 X 10^{-6}} = 10K\Omega$

$R_D = 10K\Omega$

APPARATUS REQUIRED:

1. Op-amp-4no’s
2. Resistors -1KΩ (1 no), 10KΩ (7 no’s).
3. Capacitors-0.1µF(2)
4. Signal generator
5. CRO
6. Connecting wires and Breadboard.

THEORY:

PROPORTIONAL CONTROL

A controller mode in which the controller output is directly proportional to the error signal.
$U(t) = MV(t) = K_P * e_p + P_O$
Where
P is controller output
K_P is proportional gain
e_p is error in percentage of variable range
P_O is controller output with no error (%)

PROPORTIONAL + INTEGRAL CONTROL

This is a control mode that results from a combination of the proportional mode and the integral mode. The analytical expression for this control process is given by
$U(t) = MV(t) = K_P * e_p + K_P K_i \int_o^t ep \, dt + P_i(0)$
Where
$P_i(0)$ is the integral term

The main advantage of this composite control mode is that the one to one correspondence of the proportional mode is available and the integral mode eliminates the inherent offset.

PROPORTIONAL + DERIVATIVE

Derivative control action combined with proportional gives us a controller which is good on the process having a appreciable lag . Because the process lag can be compensated by the anticipating nature of derivative action, necessary to counteract the time delay associated with such control action.
$U(t) = MV(t) = k_d * d/dt * e(t) + P_i(0)$

PROPORTIONAL+ INTEGRAL +DERIVATIVE

When all the three effects are combined together we obtain the benefits of each control action of good human operator on a control application. A three mode controller contains the stability of proportional control and ability to eliminate offset, because of reset control and ability to provide immediate correction for the magnitude of disturbance because of rate control. The PID control scheme is named after its three correcting terms, whose sum constitutes the manipulated variable (MV). The proportional, integral, and derivative terms are summed to calculate the output of the PID controller. Defining $u(t)$ as the controller output, the final form of the PID algorithm is:

$U(t) = MV(t) = K_P * e_p + K_i \int_o^t ep\, dt + k_{d*} d/dt * e(t)$

Where K_p: Proportional gain, a tuning parameter

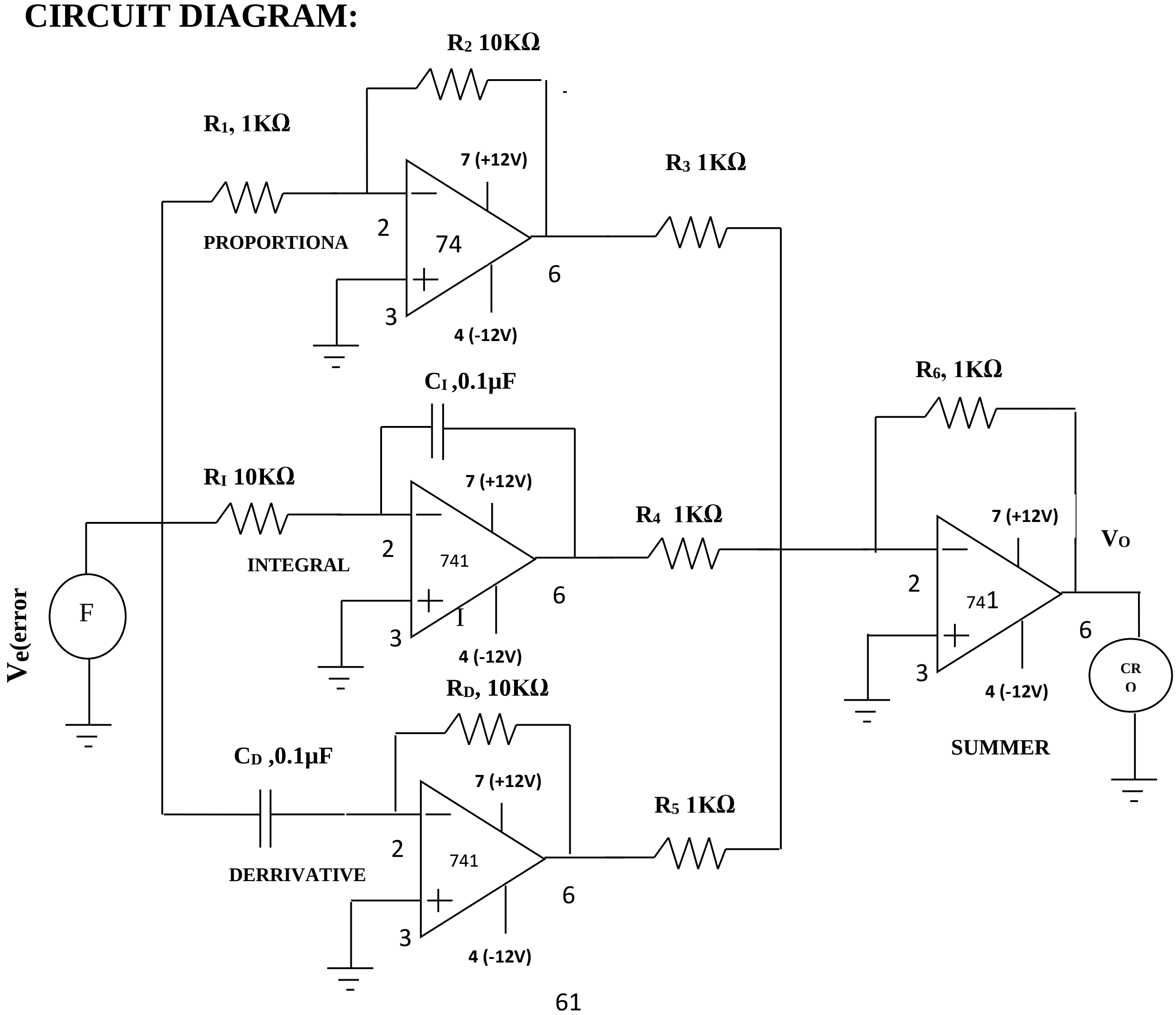
K_i: Integral gain, a tuning parameter

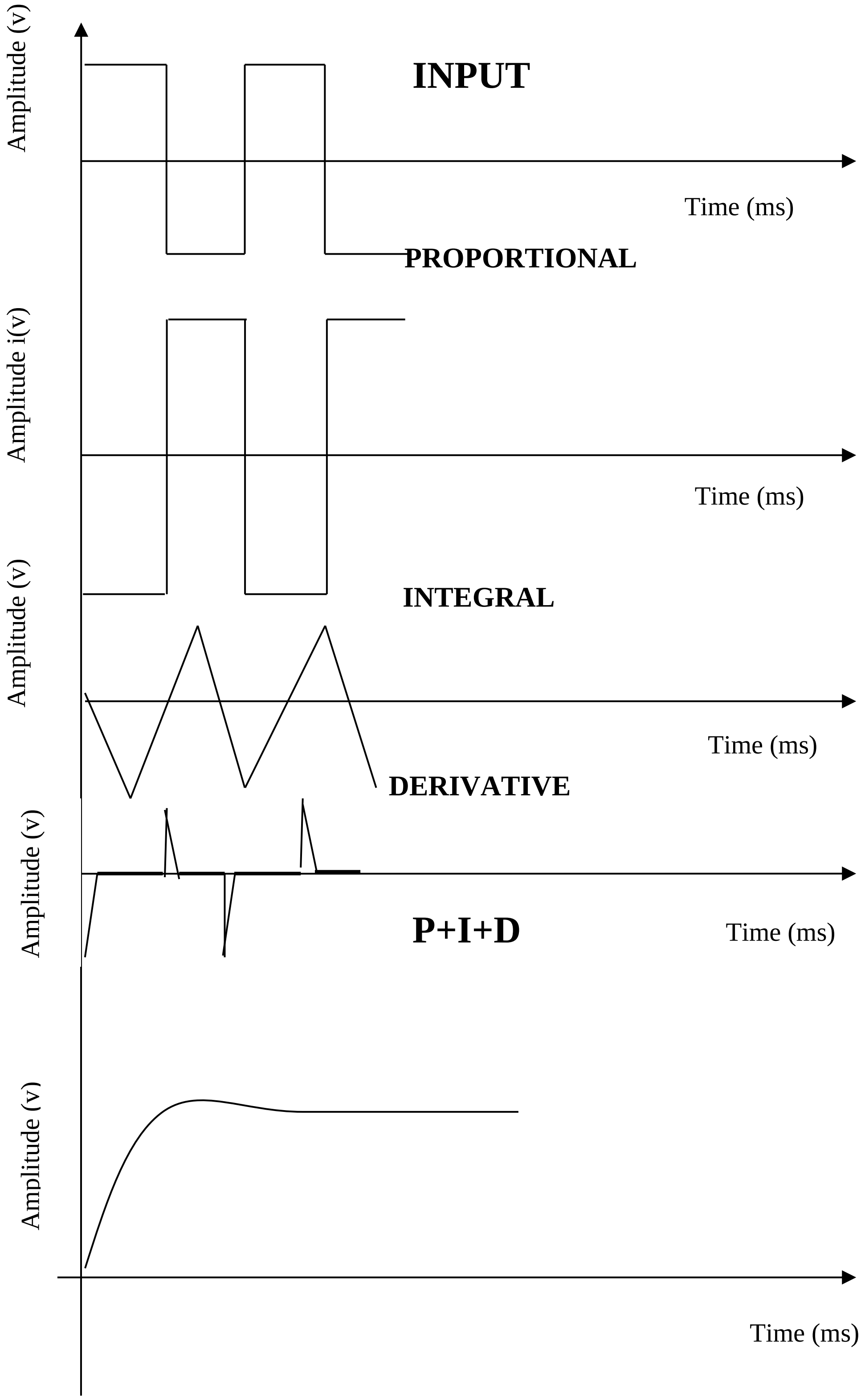
K_d: Derivative gain, a tuning parameter

e: Error = SP – PV

t: Time or instantaneous time (the present)

CIRCUIT DIAGRAM:




INPUT
Amplitude (v)
Time (ms)
PROPORTIONAL
Amplitude i(v)
Time (ms)
INTEGRAL
Amplitude (v)
Time (ms)
DERIVATIVE
Amplitude (v)
Time (ms)
P+I+D
Amplitude (v)
Time (ms)

TABULATION AND MODEL GRAPH:

Amplitude in volts	**I/P**	**P**	**I**	**D**	**PID**
Time period in (ms)					

Procedure:

1. Connections are made as per the circuit diagram.
2. Input error voltage is set in function generator.
3. Output voltage for various modes P,I,D, PID are taken.
4. The output waveforms are traced for various controller modes.
5. Calculations for G_p,$G_{I,}$$G_D$ are done using the output voltage obtained practically.
6. Thus the theoretical values of gain G_p,$G_{I,}$,G_D are verified with practical values of G_p,$G_{I,,}$$G_{D.}$

Using micro controller 8051

Start:

previous_error = error or 0 if undefined

error = setpoint - actual_position

P = Kp * error

I = I + Ki * error * dt

D = Kd * (error - previous_error) / dt

output = P + I + D

wait(dt)

goto start

Result

Thus the PID controller was designed for G_p=10, $G_I = 1000s^{-1}$, $G_D = 0.001s$ and the controller output was verified for the given error input.

EX.NO:9	DESIGN OF A MULTI-CHANNEL DATA ACQUISITION SYSTEM
DATE:	

AIM

To design a multichannel data acquisition system.

There are two types of DAQ.

1. single channel DAQ
2. Multi channel DAQ

MULTICHANNEL DAQ:

The various subsystem of DAQ system can be timed shared by two or more input sources.

The Multichannel analog multiplexed DAQ is shown .It has a single analog to digital converter. This A/D has an input which is selected for multiplexer.

The individual analog signals are applied directly or after amplification and or signal conditioning whenever necessary to multiplexer.

For most efficient utilization of time, multiplexer is made to seek the next channel to be converted. while the previous data stored in sample is converted to digital form.

When the conversion is complete the status line from the converter causes the sample mode and acquires the signal of next channel.

SIGNAL CONDITIONING IN DAQ:

A simple attenuator is used to down the input gains.

Analog differentiation, precision rectification and averaging, phase detection, log conversion,ratio computing.

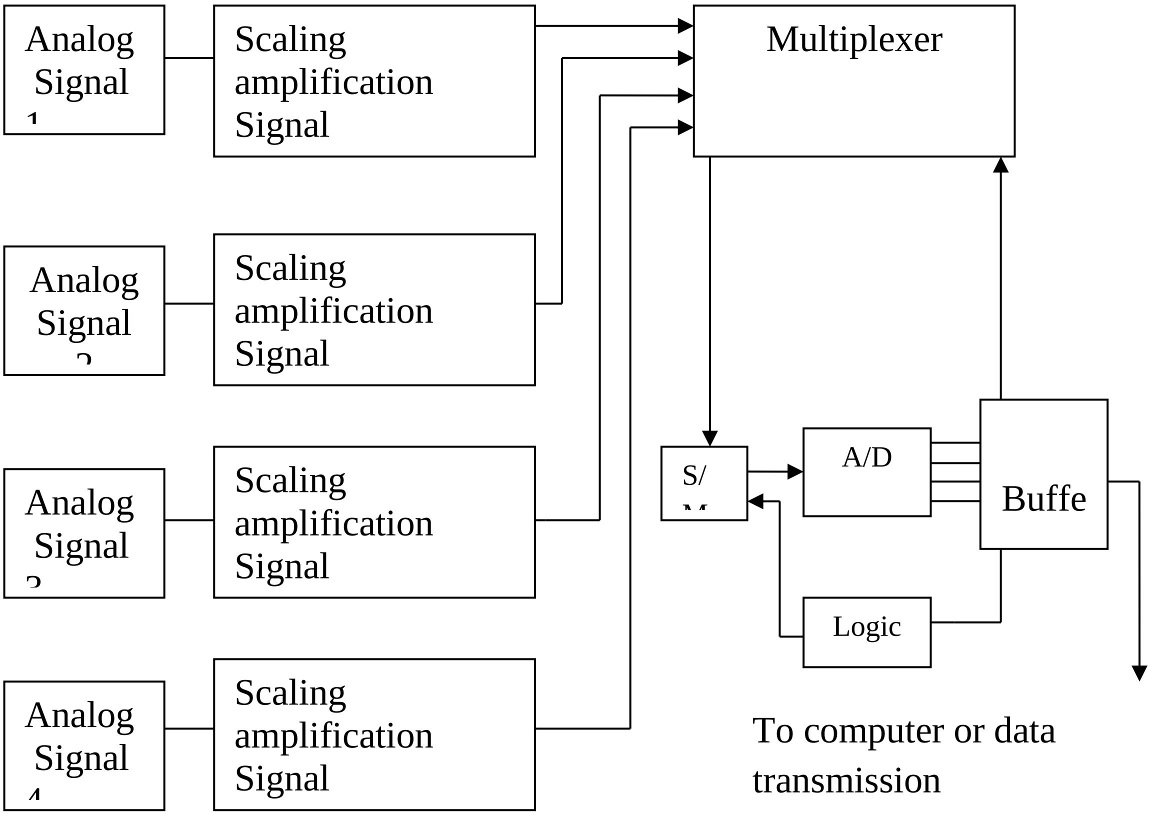
There are two methods of signal conditioning are as follows.

a) Radiometric conversion
b) Logarithmic conversion

RADIOMETRIC CONVERSION:

If the bridge output is conditioned, in such a way that output of signal amplifier is a voltage proportional to strain only an independent of the excitation voltage, the system accuracy.

CIRCUIT DIAGRAM:



LOGARITHMIC CONVERSION:

This circuit enables the measurement of a practical change in the input as a percentage of the input magnitude. Consider that a change of 1%.
(i.e) the input changes from 100mV to 101mV.

Application of DAQ

1. It is used for collecting information.
2. It converts data in to useful form
3. It is used to generate information.
4. It is used in aircraft control system

RESULT:

Thus the design of multichannel data acquisition system is studied.

EX.NO:10	DESIGN OF MULTI RANGE DP TRANSMITTER
DATE:	

AIM:

To design a 'Differential Pressure Transmitter using Piezo Resistive Transducer'

APPARATUS REQUIRED:

1. Pressure source
2. Piezo Reisistive sensor
3. IC 741,Resistors
4. Breadboard and connecting wires.

BLOCK DIAGRAM:

PROCEDURE

1. Vary the pressure from 3-15 psi from the pressure source.
2. Observe the transducer output in terms of millivolts
3. Convert the transducer output in terms of mv in to volts by using the instrumentation amplifier.
4. Then convert voltage to current for 4-20mA by using V/I converter.
5. Observe the output using Multimeter.

RESULT:

Thus the DP transmitter was designed for the range of 3-15 psi to 4-20mA.

EX.NO:11	PIPING AND INSTRUMENTATION DIAGRAM – CASE STUDY.
DATE:	

AIM:

To study the piping and instrumentation diagram.

THEORY:

Process diagrams can be broken down into two major categories: process **flow diagrams** (PFDs) and **process and instrument drawings (P&IDs),** sometimes called piping and instrumentation drawings. A flow diagram is a simple illustration that uses process symbols to describe the primary flow path through a unit. A process flow diagram provides a quick snapshot of the operating unit. Flow diagrams include all primary equipment and flows. A technician can use this document to trace the primary flow of chemicals through the unit. Secondary or minor flows are not included. Complex control loops and instrumentation are not included. The flow diagram is used for visitor information and new employee training.A process and instrument drawing is more complex. The P&ID includes a graphic representation of the equipment, piping, and instrumentation. Modern process control can be clearly inserted into the drawing to provide a process technician with a complete picture of electronic and instrument systems. Process operators can look at their process and see how the engineering department has automated the unit. Pressure, temperature, flow, and level control loops are all included on the unit P&ID.

Basic Instrument Symbols:

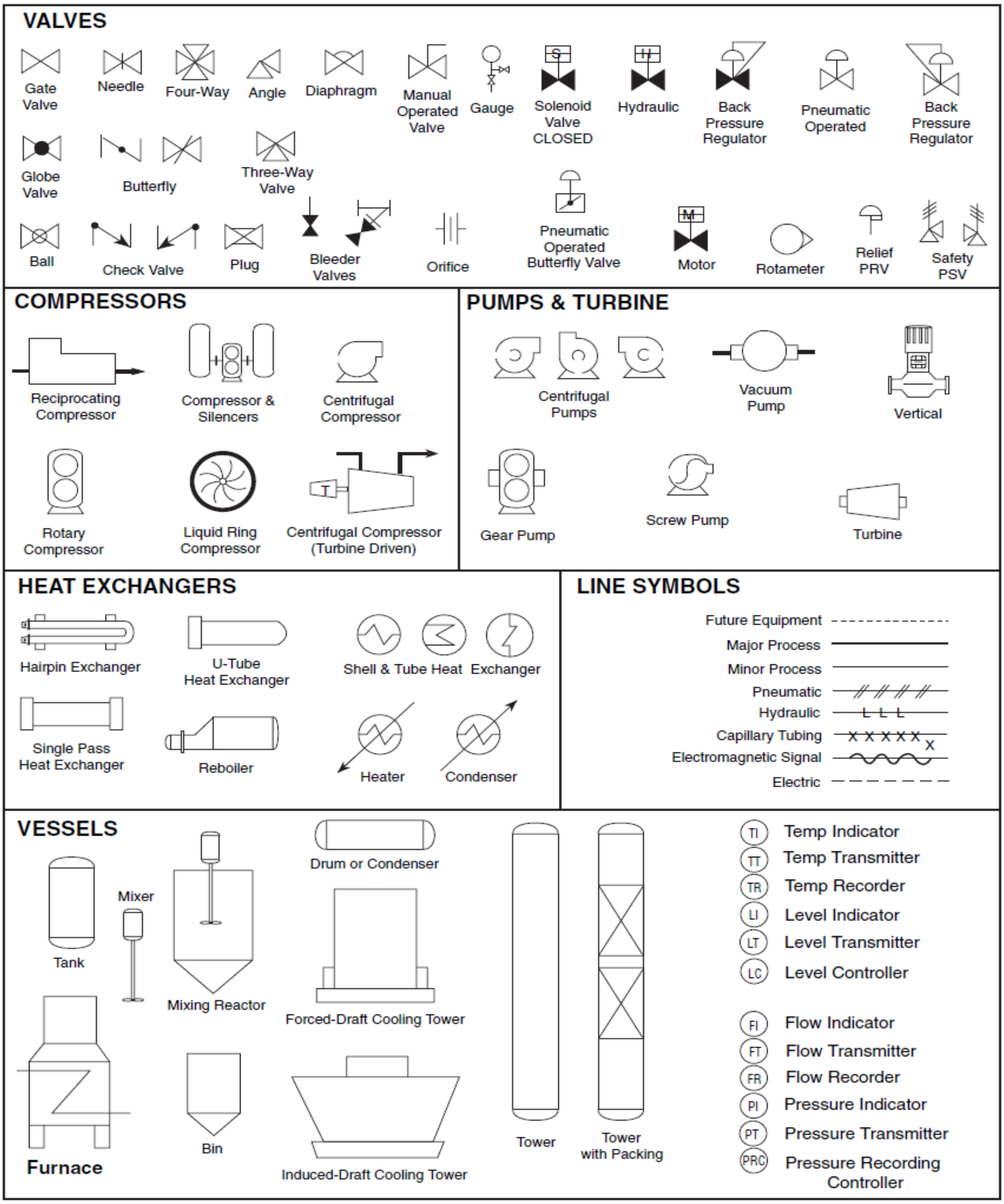


Fig.1 - Process and Instrument Symbols

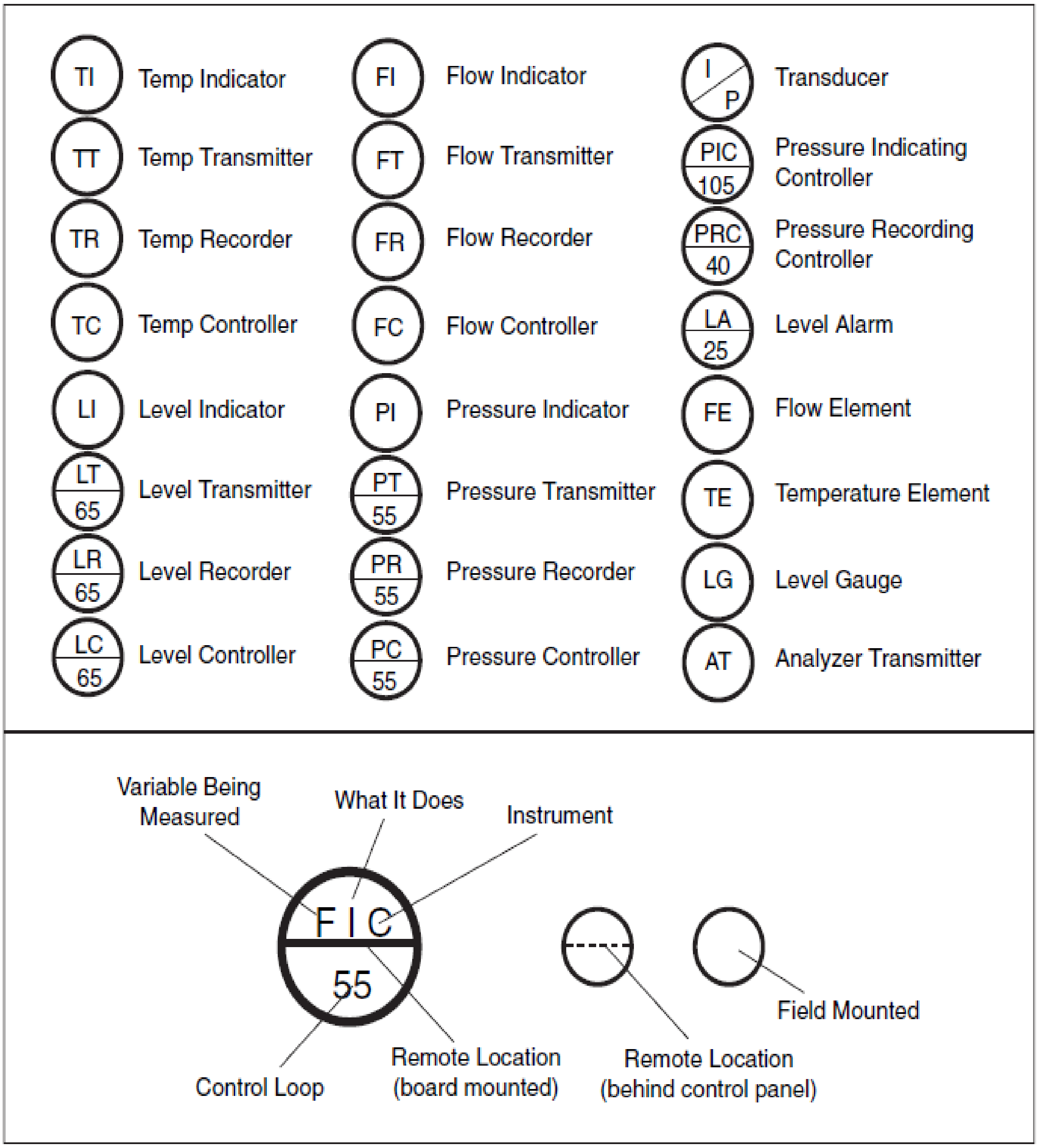


Fig 1 - Process and Instrument Symbols

Process technicians use P&IDs to identify all of the equipment, instruments, and piping found in their units. New technicians use these drawings during their initial training period. Knowing and recognizing these symbols is important for a new technician. The chemical processing industry has assigned a symbol for each type of valve, pump, compressor, steam turbine, heat exchanger, cooling tower, basic instrumentation, reactor, distillation column, furnace, and boiler. There are symbols to represent major and minor process lines and pneumatic, hydraulic, or electric lines, and there is a wide variety of electrical symbols.

Case Study

Flow Diagrams

New technicians are required to study a simple flow diagram of their assigned operating system. Process flow diagrams typically include the major equipment and piping path the process takes through the unit. As operators learn more about symbols and diagrams, they graduate to the much more complex P&IDs. Some symbols are common among plants; others differ from plant to plant. Some standardization of process symbols and diagrams is taking place. The symbols used in this chapter reflect a wide variety of petrochemical and refinery operations. The PFD that shows the basic relationships and flow paths found in a process unit. It is easier to understand a simple flow diagram if it is broken down into sections: feed, preheating, the process, and the final products. This simple left-to-right approach allows a technician to identify where the process starts and where it will eventually end. The feed section includes the feed tanks, mixers, piping, and valves. In the second step, the process flow is gradually heated for processing. This section includes heat exchangers and furnaces. In the third section, the process is included. Typical examples found in the process section could include distillation columns or reactors. The process area is a complex collection of equipment that works together to produce products that will be sent to the final section.

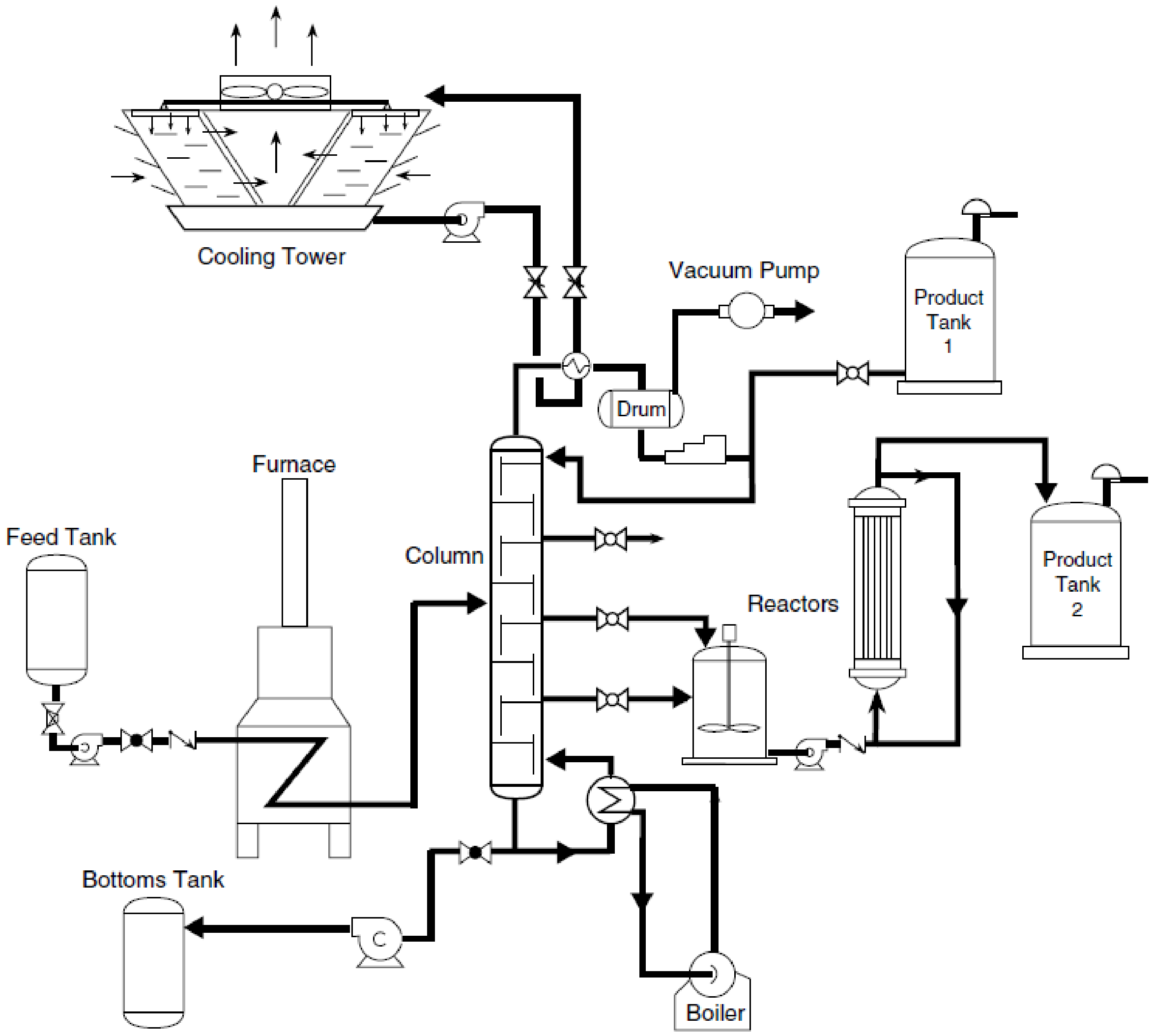


Fig 2 - Process Flow Diagram (PFD)

Process and Instrument Drawings

A P&ID is a complex representation of the various units found in a plant. It is used by people in a variety of crafts. The primary users of the document after plant startup are process technicians and instrument and electrical, mechanical, safety, and engineering personnel. In order to read a P&ID, the technician needs an understanding of the equipment, instrumentation, and technology. The next step in using a P&ID is to memorize your plant's process symbol list. This information can

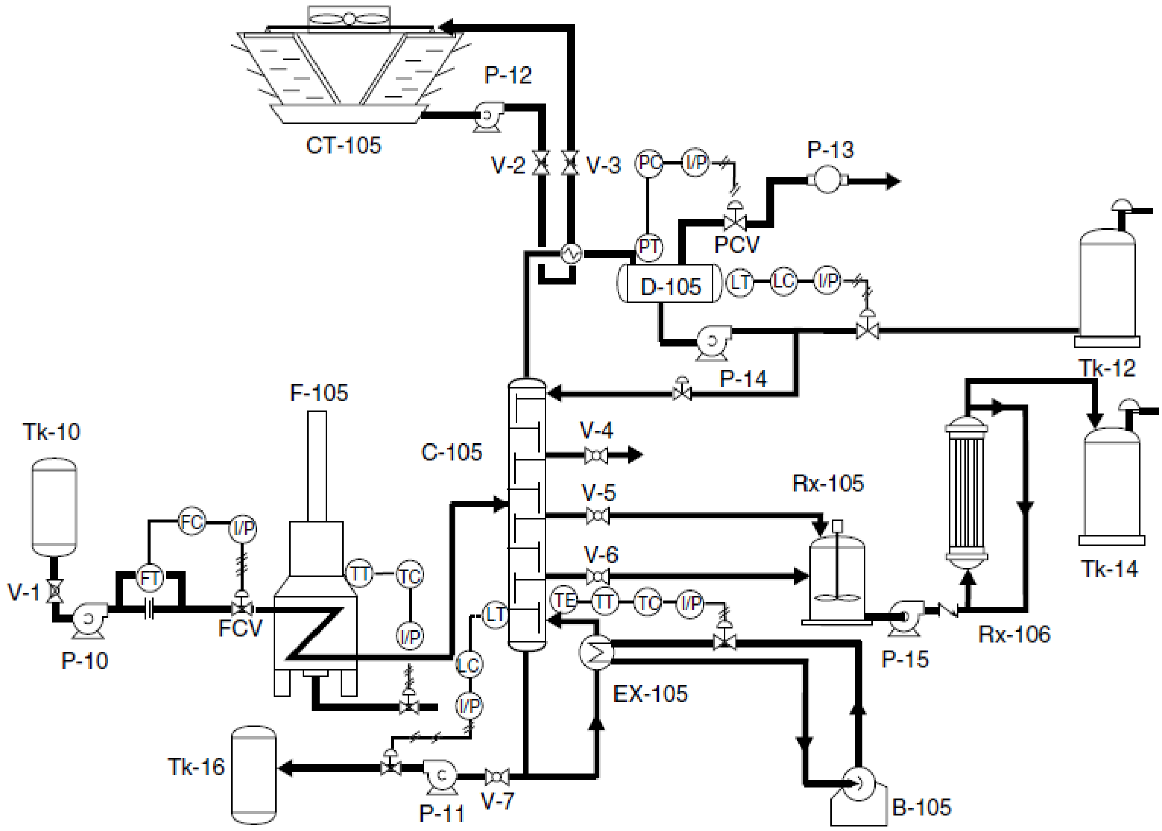


Fig 3 - Process and Instrument Diagram (P&ID)

be found on the process legend. Process and instrument drawings have a variety of elements, including flow diagrams, equipment locations, elevation plans, electrical layouts, loop diagrams, title blocks and **legends,** and **foundation drawings.** The entire P&ID provides a three-dimensional look at the various operating units in a plant.

RESULT:

Thus the piping and instrumentation diagram was drawn and studied.

EX.NO:12	**PREPARATION OF DOCUMENTATION OF INSTRUMENTATION PROJECT AND PROJECT SCHEDULING FOR THE ABOVE (CASE STUDY)**
DATE:	

AIM

To steady the steps required to schedule a new project.

THEORY

Commissioning of a platform of a new plant by one of the following ways.

- Execution and commissioning of a new plant.
- Renovating new plant.

Execution and Commissioning of a new project involves mapping customer needs, working out and fixing a system suitable based on the available fuel, turbine selection, preparation of front end engineering, mass plant layout, control schemes, engineering vendor sourcing, manufacturing inspection plan, project scheduling etc.

In case of old plant renovation, careful study of the excising layout, analysis of operation of log sheets of residual type is required.

Assessment of plant is carried out to enable and conclude necessary, upgrade equipment necessary for renovation.

Renovation and modernization of existing power plant

- Improvement based on change of fuel capacity, enhancement and efficiency improvement.
- Solution based solving system to solve temperature problems, repeated failure in particular ratio to remove ratio limitations.
- Control and instruments modernization consultant and provides servicing in the following sectors.
- Engineering studies:

  * Conduct product flexibility studies.

  * Engineering analysis for trouble shooting.

  * Conductivity assessment and removing type analysis.

* Solid modeling of equipment assembly.

Engineering assignment:

- Vendor selection and sourcing of materials, executive follow up for scheduled job completion. Third party inspection for power plant equipment, lower target prize for the plant equipment based on preparation and project specification to be prepared.
- Spare sourcing

Advantages:

Consultant assures the following benefits.

- Proven performance
- Complete solution covered in package.
- Suitable for latest pollution norms
- Faster execution
- Minimum initial instrument.

The consultant studies all the minute details before offering the best suitable option proposed with alternatives and suggestions for customer assessment.

Typical project execution steps conceptualization:

Where design basic operating load causes and I schemes and M requirements, site setup, skilled and semi-skilled labor apart from market situation are assessed and planned.

Engineering:

Where equipment sizing, layout pipeline sizing, engineering equipment generating a valid schedule and foundation and data generation port of the project and assessed.

Project assurance plan:

Working out quality assurance plan for a raw material, inspecting bought out items, test and run witness review of equipment.

Execution:

Deciding execution, sequence identifying, Parallel plants, schedule its man power required.

RESULT:

Thus the steps involved in project scheduling were studied.

ADDITIONAL EXPERIMENT

EX.NO:13	DESIGN AND IMPLEMENTATION OF SIGNAL CONDITIONING CIRCUIT FOR RTD USING INSTRUMENTATION AMPLIFIER
DATE:	

AIM

To design a signal conditioning circuit to RTD. The specification are as follows: Temperature range: 30C-100C (approximately)

Output voltage range: 0-5VDC.

Sensor: RTD (Pt 100).

Current through RTD: Not to exceed 0.01469A

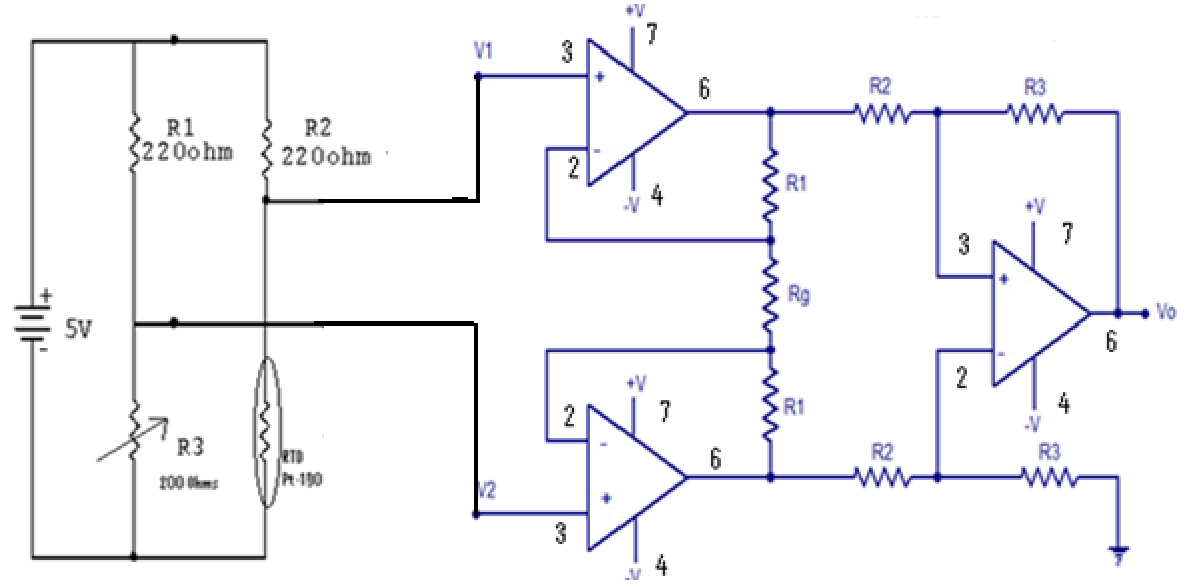
APPARATUS REQUIRED

1. Op-amp-2 No's
2. Resistors-- 220Ω-4, 1k-5,19.2k-1
3. Variable resistor (1K) -1
4. Power supply 0-30v,+/-12v
5. Voltmeter (0-30)v
6. Bread board and connecting wires.

THEORY

Water flows through a pipe which is immersed in another hot liquid, a control systems is to regulate the water temperature by controlling the flow. For this purpose it is required to measure the temperature in range from 30°c to 100°c using RTD.A control system will regulate the water temperature so a measurement must be provided to convert 30°c to 100 °c into 0 to 5 volts using Pt – 100.The error due to self heating of the RTD should not exceed 1°c.Power dissipation constant(P_D) of RTD is 30 mW/°c.

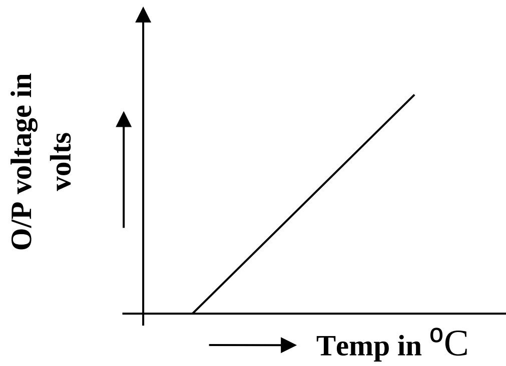
CIRCUIT DIAGRAM:



TABULAR COLUMN

S.No	Temperature in °C	Bridge o/p in volts	Output voltage in volts
1	30		
2	50		
3	60		
4	75		
5	100		

MODEL GRAPH



PROCEDURE

1.Connections are made as per the circuit diagram.

2.Note down the o/p voltage of 0v at 30°C.

3.Note down the bridge o/p voltage and amplifier o/p voltage for every 10°C rise in temperature.

4.Plot the graph for temp Vs o/p voltage.

RESULT

Thus the signal conditioning circuit for RTD using instrumentation amplifier is designed and implemented.

VIVA QUESTIONS AND ANSWERS

EX.NO 1 DESIGN OF INSTRUMENTATION AMPLIFIER.

1. What is the need for an instrumentation amplifier?

In a number of industrial and consumer applications, the measurements of physical Quantities are usually done with the help of transducers. The output of transducer has to be amplified So that it can drive the indicator or display system. This function is performed by an instrumentation amplifier.

2. List the features of instrumentation amplifier:

- High gain accuracy
- High CMRR
- High gain stability with low temperature co-efficient
- Low dc offset
- Low output impedance

3. What is meant by instrumentation amplifier?

The special amplifier which is used for such a low level amplification with high CMRR, high input impedance to avoid loading, low power consumption and some other features is called an instrumentation amplifier. It is also called data amplifier and is basically a difference amplifier.

4. What are the applications of Instrumentation amplifier?

1. Temperature controller.
2. Light intensity meter.
3. Analog weight Scale.
4. Temperature indicator

5. What are the requirements of good instrumentation amplifier?

1. Finite, accurate, and stable gain.
2. Easier gain adjustment.
3. High Input impedance.

4. Low output impedance.

5. High CMRR.

6. Low power consumption.

7. Low thermal and time drifts.

8. High slew rate.

EX.NO 2 DESIGN OF FIRST AND SECOND ORDER FILTER

1. Define Filter.

A filter is a circuit that is designed to pass a specified band of frequencies while attenuating all the signals outside that band. It is a frequency selective circuit.

2. Define cut off frequency.

3. List the application of LPF,HPF and BPF

4. What is a state variable filter?

It uses three or four Op-Amps & provides low pass, high pass, band pass & notch Filter characteristics simultaneously. Problems such as noise, transients, contact bounce, are eliminated.

EX.NO 3 DESIGN OF REGULATED POWER SUPPLY

1. What are the components of a basic voltage regulator?

(i) Voltage reference

(ii) Error amplifier

(iii) Feedback network.

(iv) Active series or shunt control element.

2. What are the advantages of IC voltage regulators?

(i) Easy to use.

(ii) It greatly simplifies power supply design.

(iii) Due to mass production, low in cost.

(iv) Versatile.

(v) Used for local regulation.

3.State some important features of IC 723.

(i) Input & output short circuit protection is provided.

(ii) It has good line & load regulation.

(iii) Low standby current drain.

(iv) Smaller size, lower cost.

(v) Low temperature drift & high ripple rejection.

4. What are the important blocks of IC 723?

(i) Temperature compensated voltage reference source.

(ii) An OpAmp circuit used as an error amplifier.

(iii) A series pass transistor capable of 150mA output current.

(iv) Transistor used to limit output current

5. State any three applications of IC723.

• Basic low voltage regulator.

• Low voltage high current regulator.

• Negative voltage regulator.

6. What is the protection circuits used in regulators?

• Constant current limiting

• Foldback current limiting

• Over voltage protection

• Thermal shutdown.

7. What are the advantages of LM 317 regulator over fixed voltage regulator?

• Improved line & load regulation by a factor of 10 or more.

• Improved reliability for the power supply.

• Improved overload protection i.e., greater load current can be drawn over the given operating temperature range.

8. What are the limitations of LM 317 linear voltage regulators?

- The required input transformer is bulky & expensive.
- Due to low line frequency, large values of filter capacitors are required.
- Input must be greater than output voltage.
- For higher input voltages, efficiency decreases.

9. What are the types of switching regulators?

Switched mode regulator.

Switched mode converter.

10. How the current boosting is achieved in an IC 723?

The maximum load current of IC 723 is 150mA .If the current is to be boosted then external resistor Q1 is connected to the output terminal.

11. Mention some switched capacitor filter IC's.

1. MF5-Universal second order filter
2. MF6-Unity gain sixth order Butterworth LP filter.
3. MF8-Two second order BP filter.
4. MF10- State variable filter IC.

<u>E.NO 3(B)DESIGN AND IMPLEMENTATION OF V/I AND I/V CONVERTERS.</u>

1. What are the types of V/I converter.

1. Floating type.

2. Grounded type.

2. Write the applications of V-I Converter.

1. Low Voltage D.C Voltmeter.

2. Low Voltage A.C Voltmeter.

3. Zener diode tester

4. Diode tester and Match filter.

3. **Write the applications of I- V Converter.**
4. **Why (4-20)mA range is used for conversion?**

EX.NO 5 (A)DESIGN OF SIGNAL CONDITIONING CIRCUIT FOR STRAIN GAUGE.

1. Define stress.

When an external force acts on a body, it undergoes deformation. At the same time the body resists deformation. The magnitude of the resisting force is numerically equal to the applied force. This internal resisting force per unit area is called stress.

Stress = Force/Area

2. Define strain

When a body is subjected to an external force, there is some change of dimension in the body. Numerically the strain is equal to the ratio of change in length to the original length

Of the body.= P/A unit is N/mm^2

Strain = Change in length/Original length

$e = \Delta L/L$

3. State Hooke's law.

It states that when a material is loaded, within its elastic limit, the stress is directly proportional to the strain.

4. Define shear stress and shear strain.

The two equal and opposite force act tangentially on any cross sectional plane of the body tending to slide one part of the body over the other part. The stress induced is called shear stress and the corresponding strain is known as shear strain.

5. Define Poisson's ration.

When a body is stressed, within its elastic limit, the ratio of lateral strain to the longitudinal strain is constant for a given material.

Poisson' ratio (μ or 1/m) = Lateral strain /Longitudinal strain.

6. State the relationship between Young's Modulus and Modulus of Rigidity.

$E = 2G (1+1/m)$

Where,

E - Young's Modulus

K - Bulk Modulus

1/m - Poisson's ratio

7. Define strain energy.

Whenever a body is strained, some amount of energy is absorbed in the body. The energy which is absorbed in the body due to straining effect is known as strain energy.

8. What is resilience?

The total strain energy stored in the body is generally known as resilience.

9. State proof resilience.

The maximum strain energy that can be stored in a material within elastic limit is known as proof resilience.

10. Define – Young's modulus.

The ratio of stress and strain is constant within the elastic limit.

E = Stress/Strain

11. Define Bulk-modulus.

The ratio of direct stress to volumetric strain.

K = Direct stress

Volumetric strain

12. Define- lateral strain.

When a body is subjected to axial load P. The length of the body is increased. The axial deformation of the length of the body is called lateral strain.

13. Define- longitudinal strain.

The strain right angle to the direction of the applied load is called lateral strain.

EX.NO 6 DESIGN OF ORIFICE PLATE AND ROTAMETER.

1. What is Rotameter?

It is an example of variable area flow meter. When fluid enters lopped moves from the Bottom to top. Distance is proportional to the flow rate.

2. List some example of inferential flow meter.

Turbine flow meters

Target flow meters

Ultrasonic flow meters.

3. Mention some temperature sensor.

Thermocouple

Thermistor

RTD

RTD

4. What are the different types of orifice?

Concentric orifice, Eccentric, Segmental, Quadrant edge

5. Define concentric orifice?

It has a circular hole in the middle and is installed in the pipe line with the hole concentric to the pipe. Its thickness depends upon pipe line size.

6. Define eccentric.

It is installed in with the bore tangential to the upper surface of the pipe, it is used where the liquid contains a relatively high % of dissolved gases.

7.Define segmental.

Its hole diameter is 98% of pipe diameter. It is installed with a curved section of the opening coincident with the lower surface of the pipe.

8. Define quadrant.

Edges is rounded to form a quarter circle. Used for the flow of heavy crudes and slurry and Viscous flows.

9.what ae the different tapping of orifice?

Flange tape, Pipe tape , Venacontracta tape

10. Give the details about flange tap.

Located one inch either side of orifice plate.

Pressure difference is an integral part of the orifice.

11. Give the details about pipe tap.

Located pipe diameter from the orifice.

Only the permanent pressure difference across the orifice is utilized.

12. Give the details about vena contracta tap.

Downstream pressure tape is located variable distance from the orifice.

Pressure difference is maximum for the given flow.

13.List the advantages of the orifice plate

Used in wide range of pipe sizes

Used with pressure differential device.

Available in many materials

14. List the disadvantages of the orifice plate.

- High permanent pressure loss
- Reduces the use in slurry services
- Accuracy depends on the care during installation.
- It has the square root characteristics.

EX.NO 8 DESIGN OF PID CONTROLLER (USING OPERATIONAL AMPLIFIER AND MICROPROCESSOR).

1.What is a First Order System?

The input and output relationship of a control system can be expressed by a differential equation. The order of the system is given by the order of the differential equation governing the system. If the system is governed by n^{th} order differential equation, then the system is called n^{th} order system. For a first order system the order of the equation is one.

2. What is a second order system?

The input and output relationship of a transfer function is given by a differential equation. The order of the system is given by the order of differential equation governing the system. If the order of the differential equation is two then the system is called second order system.

3. What is damping?

Damping is any effect that tends to reduce the amplitude of oscillations in an oscillatory system.

4. What is damping ratio?

This is defined as the ratio of the actual damping to the critical damping. Output C(s) of a second order system depends on the value of damping ratio (η).

5. What is a transfer function?

Transfer function of a linear time invariant continuous system is defined as ratio of Lapalce of output variable / Laplace of input variable with all initial conditions taken to be zero.

6. What is Delay Time?

It is the time taken for the response of a second order system to reach 50% of the final value, for the very first time.

7. What is rise time?

It is the time taken for the response of a second order system to rise from 0 to 100% for the very first time.

8. What is peak time (t_p)?

It is the time taken for the response to reach the peak value for the very first time

9. What is peak overshoot?

It is defined as the ratio of the maximum peak value measured from initial value to final value.

10. What is settling time?

It is defined as the time taken by the response to reach and stay with in a specified error.

11. What is time constant?

It is an alternative measure for settling time. It is the time required by the system response decay to 37 % of its initial value or time to reach 63 % of the final value in response to a fixed change in input.

12. What is the use of a controller?

A controller is used to achieve a better control action by modifying the difference signal E(S).

13. What is proportional controller?

Proportional controller produces an actuating output, which is proportional to the error signal.

14. What are the advantages of proportional controller?

(i) Relative stability of the system is improved

(ii) Noise signal rejection is better

(iii) Accuracy of steady state tracking is improved.

(iv)As loop gain increases sensibility of system to parameter variations decreased.

14. What are the disadvantages of proportional controller?

It produces steady state error.

15. What is steady state error?

It is defined as the difference between the ideal and final values of the system output after the transient has expired.

16. What is a PI controller?

A PI controller is one which produces an actuating output, which is proportional to two terms, they are, (i) Error signal (ii) Integral of error signal.

17. What are the drawbacks of PI controller?

PI controller needs special provisions to remove integral wind up.

18. What is a PID controller?

i) Proportional to error

ii) Proportional to Integral of error.

iii) Proportional to derivative of error.

19. what is an anticipatory controller?

The PID controller is also called the anticipatory controller as it can anticipate future errors with the knowledge of the current error

87. what is a Ladder Diagram?

The ladder diagram serves as a basis for writing programs for a PLC. The ladder diagram reflects a conventional wiring diagram which shows the physical arrangement of various components used.

EX.NO 9 DESIGN OF A MULTI-CHANNEL DATA ACQUISITION SYSTEM.

1. What is meant by acquisition?
2. How will you select DAQ for any application?
3. What is interfacing?
4. What is serial and parallel interfacing?
5. What are all the serial communication protocol available ?

EX.NO 10 DESIGN OF MULTI RANGE DP TRANSMITTER.

1. what is DPT?
2. Define pressure
3. What are the devices used for measuring pressure?
4. Name some low and medium pressure measuring devices.
5. Define vacuum.
6. What is meant by absolute pressure?
7. What is meant by gauge pressure?

EX.NO 11 & 12 PIPING AND INSTRUMENTATION DIAGRAM – CASE STUDY

1. what are the four fundamental instructions used in PLC program?

i) LD, LDI – input loaded or inverted loaded before it is read in the accumulator.

ii) AND, ANI – AND & AND inverse instruction

iii) OR, ORI – OR & OR inverse instruction

iv) OUT – instruction output A to the output memory register.

2. what is a DCS?

A Distributed control system is one which utilizes microprocessor based Controllers and data acquisition modules housed in cabinets at the process stations which can be controlled at a central place.

3. Advantages of DCS:

i) Good scalability and expandability

ii) Control capability is digitized

iii) Non-occurrence of single point failure.

iv) Low cost maintenance

4. What is a Process?

A Process denotes an operation or series of operations. A Process can be described by either an Ordinary differential equation (lumped parameter system) or by partial differential equation (Distributed parameter system).

5. Define Set point Variable.

Set point variable is set by the operator, master controller (or) computer as a desired value. It is also sometimes called as ‘reference variable’.

6. Define Manipulated Variable.

Manipulated Variable is the one that can be changed in order to maintain the controlled Variable at the set point value.

7. Define Controlled Variable.

Controlled Variable is the one that must be maintaining precisely at the set point.

8. Define Load Variable.

Load Variables (or) Load disturbances are those variables that cause disturbances in the Process, which may change either continuously (or) instantaneously with some function of time.

9. Mention some application areas where there is need for automatic process control.

Automatic Process control devices are used in almost every phase of industrial Operations.

10. Define Proportional Gain.

The adjustable parameter of the proportional mode K_P is called the Proportional gain or proportional sensitivity.

11. Define Proportional Band.

The range of error to cover the 0% to 100% controller output is called the proportional band because the one to one correspondence exists only for errors in this range.

12. Define Integral time.

Integral time is defined as the time of change of manipulated variable caused by a unit change of deviation.

13. Define Derivative time or Define Differential time.

Derivative time (or Differential time) is the time interval by which the rate of action advances the effect of proportional action.