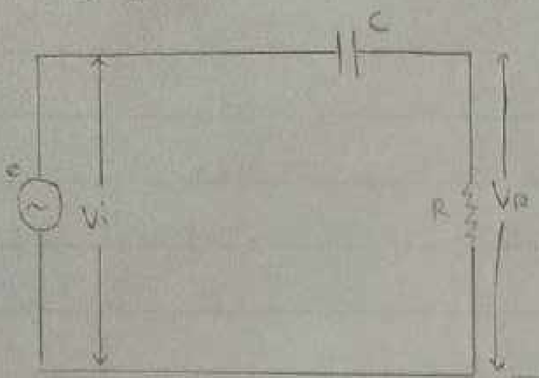
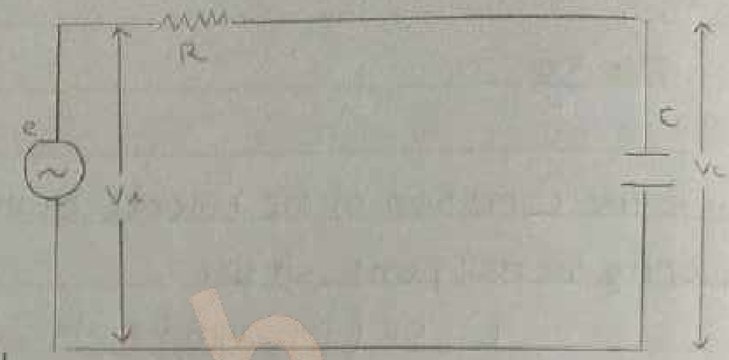
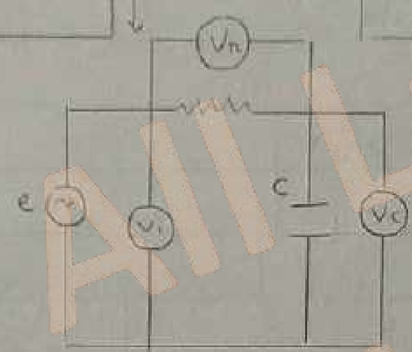
Diagram:

High pass filter:



low Pass filter:





Observations: R = 1kΩ , C = 0·1 μF , V_i = 3V

High Pass Filter:

S. NO	f (Hz)	V_R (V)	V_R/V_i
1.	100	0·28	0·09
2.	200	0·44	0·15
3.	300	0·7	0·23
4.	400	0·9	0·33
5.	500	1·12	0·37
6.	600	1·3	0·43
7.	700	1·48	0·49
8.	800	1·5	0·5
9.	900	1·6	0·53
10.	1000	1·75	0·58
11.	2000	2·45	0·82
12.	3000	2·7	0·9
13.	4000	2·8	0·93

S. NO	F (Hz)	V_R (V)	V_R/V_i
14.	5000	2·9	0·97
15.	6000	2·9	0·97
16.	7000	2·9	0·97
17.	8000	2·9	0·97

Aim: To study an RC circuit as a low pass & high pass filter.

Apparatus:

An audio oscillator, a capacitor (0.1 μF), a resistance (~1 kΩ), AC voltmeters, connecting wires.

Theory:

High pass filter:

In a series RC circuit with an AC ~~circuit~~ input, if the output is taken across R, then the circuit acts as a high pass filter and passes the high frequency components of the input unaltered.

The working of a high pass filter can be simply explained as: At 0 frequency the reactance of C is infinite, and it acts like an open switch. No current flows through R, thus V_R is 0. With increase in frequency, the capacitive reactance decreases, the current flows through R & V_R increases. At infinite frequency, the capacitive reactance is 0 and acts like a closed switch, so

$V_R = V_i$

$$\frac{V_R}{V_i} = \frac{1}{\sqrt{2}} \quad \text{— (i)}$$

so, $V_i = \sqrt{V_R^2 + V_C^2}$

(i) becomes $\dfrac{V_R}{\sqrt{V_R^2+V_C^2}} = \dfrac{1}{\sqrt{2}} = 0.707$

or $V_R = V_C$

$\Rightarrow R = \dfrac{1}{\omega C}$

$\Rightarrow \omega = \dfrac{1}{RC}$

and $f = f_n = \dfrac{1}{2\pi RC}$

Low Pass Filter

S No	f (Hz)	log(f)	Vc (V)	Vc/Vi
1	100	2	3	1
2	200	2.3	3	1
3	300	2.48	3	1
4	400	2.6	2.8	0.93
5	500	2.69	2.8	0.93
6	1000	3	2.5	0.83
7	2000	3.3	1.8	0.6
8	3000	3.48	1.4	0.47
9	4000	3.6	1.1	0.37
10	5000	3.69	0.9	0.3
11	6000	3.78	0.8	0.27
12	7000	3.84	0.7	0.23
13	8000	3.9	0.63	0.21
14	9000	3.95	0.56	0.19
15	10000	4	0.50	0.17
16	11,000	4.04	0.46	0.15
17	12000	4.07	0.42	0.14
18	13000	4.11	0.39	0.13
19	14000	4.14	0.36	0.13
20	15000	4.18	0.34	0.11
21	16000 (7)	4.23	0.3	0.1
22	18000	4.25	0.28	0.09
23	25000	4.4	0.2	0.07
24	40000	4.6	0.14	0.05
25	60000	4.78	0.09	0.053

Low pass filter:

If the output is taken across C in a series RC circuit, the circuit acts like a low pass filter.

The working of a low-pass filter can be simply explained this way, At 0 frequency the capacitive reactance is infinite and it acts like an open switch and $V_C = V_i$, with increase in frequency, the capacitive reactance, and consequently V_C decreases. At infinite frequency, capacitor acts like a closed switch and $V_C = 0$. Thus the circuit blocks the high freq signal & it is called a low pass circuit.

The voltage gain $\frac{V_C}{V_i}$ for the circuit of low pass filter decreases from 1 to 0 with increasing frequency. $\frac{V_C}{V_i} = 0.707$ at $f = f_n$.

Precautions and Sources of Error:

1. The values of capacitance C and resistance R should be chosen so as to keep the time constant RC large.
2. The time t and the corresponding voltage across the capacitor should be noted very carefully.
3. The capacitor should not have an appreciable leakage.