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INSTITUTE OF
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Internal Assesment Test - III

Sub:	**OPERATIONAL AMPLIFIERS AND LINEAR ICs**							Code:	15EE46
Date:	31 / 05/ 2017	Duration:	90 mins	Max Marks:	50	Sem:	IV	Branch:	EEE
Note:(i)Answer either Q1 completly or Q2 completely						**(ii)Q3,Q4 and Q5 is compulsory**			

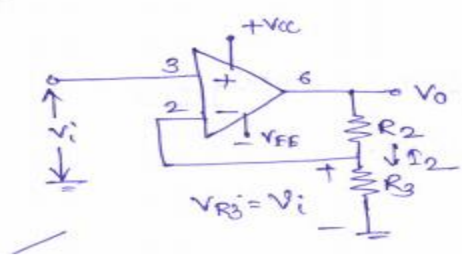
		Marks	CO	RBT
1 (a)	List the characteristics of ideal Op-amp. Demonstrate the working of Op-amp as inverting and non-inverting amplifier with circuit diagram and design.	[10]	C406.1	L1
1(b)	Discuss the operation of Op-amp as voltage series and voltage shunt feedback amplifier. Derive the closed loop gain, input resistance and output resistance of the same.	[10]	C406.1	L1
	OR			
2(a)	Design a inverting Schmitt trigger to have UTP=+3V and LTP=-5V using an Op-amp uA741 IC with supply voltage Vcc=±15V.	[10]	C406.4	L3
2(b)	Demonstrate with circuit diagram voltage to current converter with grounded load and current to voltage converter.	[10]	C406.5	L1
3	Explain the working of PLL with block diagram. Explain the function of each block in detail.	[10]	C406.6	L1
4	Explain the working of Astable multivibrator using 555 timer with internal diagram and required waveforms.	[10]	C406.6	L2
5	List the different applications of 555 timer. Explain any 2 applications in detail.	[10]	C406.6	L2

Answer
1(a)

The characteristics of an ideal op-amp are -

- → Open loop voltage gain $A_{OL} = \infty$
- → Input impedance $R_i = \infty$
- → output impedance $R_o = 0$
- → Bandwidth $BW = \infty$
- → zero offset i.e $v_o = 0$ if $v_1 = v_2 = 0$

Non inverting amplifier



~~Vo=~~

Applying KCL at port no. 2 we get, $I_{R2} = I_{R3}$

$$\frac{v_{R3}}{R_3} = \frac{V_o - V_i}{R_2}$$

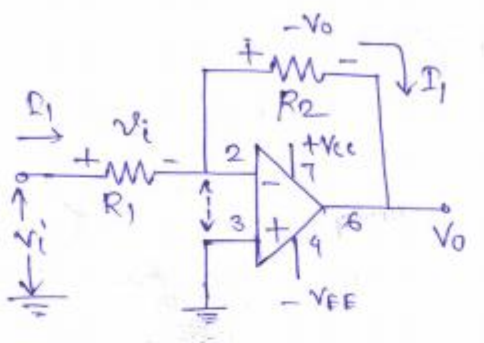
$$\text{or,} \quad \frac{v_i}{R_3} = \frac{V_o - V_i}{R_2}$$

$$\text{or,} \quad v_i \left(\frac{1}{R_2} + \frac{1}{R_3} \right) = \frac{V_o}{R_2}$$

$$\text{or,} \quad \frac{V_o}{V_i} = R_2 \cdot \frac{R_2 + R_3}{R_2 R_3} = \left(1 + \frac{R_2}{R_3}\right)$$

$$\therefore \quad \boxed{A_v = \frac{v_o}{v_i} = \left(1 + \frac{R_2}{R_3}\right)}$$

Inverting amplifier



Now, applying KCL at node 2 we get,

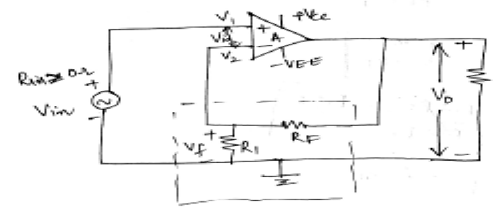
$$\frac{V_i}{R_1} = \frac{0 - V_o}{R_2}$$

$$\text{or,} \quad A_v = \frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

$$\therefore \quad \boxed{A_v = -\frac{R_2}{R_1}}$$

1(b)

(1) Voltage - series feedback amplifier



→ Used as Non-inverting amplifier.

open loop voltage gain ($A = \frac{V_o}{V_{id}}$)

closed loop voltage gain $A_F = \frac{V_o}{V_{in}}$

Gain of feedback circuit $B = \frac{V_f}{V_o}$

Negative feedback

$V_{id} = V_{in} - V_f$

V_{in} → input voltage, V_f - feedback voltage, V_{id} = diff i/p V.

feedback always like the input voltage (180°).

closed loop voltage gain

$$A_F = \frac{V_o}{V_{in}}$$

$$V_o = A(V_1 - V_2).$$

from fig $V_1 = V_{in}$

$$V_2 = V_f = V_o \times \frac{R_1}{R_1 + F_F}$$

$$V_o = A\left[V_{in} - \frac{R_1 V_o}{R_1 + R_F}\right]$$

$$V_o = A\left[\frac{V_{in}(R_1 + R_F) - R_1 V_o}{R_1 + R_F}\right]$$

$$V_o\left[1 + \frac{R_1}{R_1 + R_F}\right] = A V_{in}$$

$$V_o = \frac{A(R_1 + R_F) V_{in}}{R_1 + R_F + AR_1}$$

$$A_F = \frac{V_o}{V_{in}} = \frac{A(R_1 + R_F)}{R_1 + R_F + AR_1}$$

A is very large (10^5)

$AR_1 >> (R_1 + R_F)$ so $R_1 + R_F + AR_1 \simeq AR_1$

$$A_F = \frac{V_o}{V_{in}} = \frac{A(R_1 + R_F)}{AR_1} = 1 + \frac{R_F}{R_1} \text{ (ideal)}$$

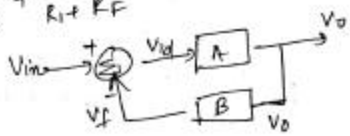
$$B = \frac{v_f}{v_0} = \frac{R_1}{R_1 + R_F}$$

Comparing A & B

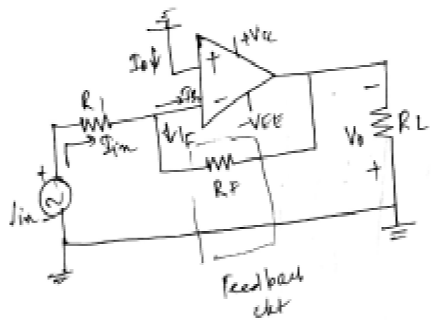
$$A_F = 1/B$$

$$A_F = \frac{A(R_1 + R_F)}{R_1 + R_F + AR_1} = \frac{A\left(\frac{R_1+R_F}{R_1+R_F}\right)}{\frac{R_1+R_F}{R_1+R_F} + \frac{AR_1}{R_1+R_F}}$$

$$A_F = \frac{A}{1 + AB}$$



Voltage shunt feedback amplifier



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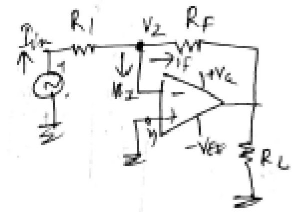


closed loop voltage gain

$i_{in} = i_F + i_B$

$i_B << \quad i_{in} \approx i_F$

$$\frac{v_{in} - v_2}{R_1} = \frac{v_2 - v_0}{R_F}$$

$v_1 - v_2 = v_0/A$

$v_1 = 0 \quad v_2 = -\frac{v_0}{A}$

$$\frac{v_{in} + v_0/A}{R_1} = \frac{-(v_0/A) - v_0}{R_F}$$

$$A_F = \frac{v_0}{v_{in}} = \frac{-AR_F}{R_1 + R_F + AR_1}$$

$AR_1 >> R_1 + R_F$

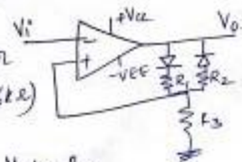
$$A_F = \frac{v_0}{v_{in}} = \frac{-R_F}{R_1}$$

2(a)

UTP = +3V LTP = −5V $V_{cc} = \pm 15V$

$R_3 = \frac{UTP}{I_1} = \frac{3}{500\mu A} = 6\times10^{-3}\times10^{6}\,\Omega$

$6k\Omega\,(5.6k\Omega)$



$UTP = \frac{V_{sat}\times R_3}{R_1+R_3}$ $LTP = \frac{V_{sat}\times R_3}{R_2+R_3}$

$3 = \frac{14\times5.6k\Omega}{R_1+5.6k\Omega}$ $3(R_1+5.6k\Omega) = 14\times5.6k\Omega$

$3R_1 + 16.8k\Omega = 78.4\times10^3$

$3R_1 = 61.6k\Omega$

$R_1 = 20k\Omega\ (18k\Omega)$

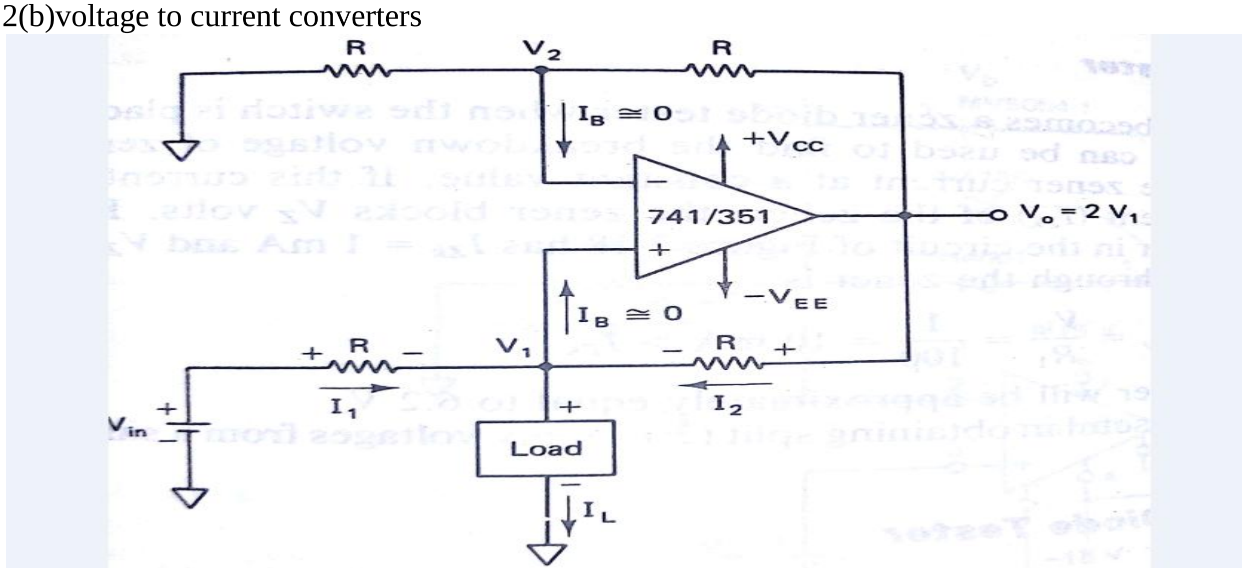
$5 = \frac{14\times5.6k\Omega}{R_2+5.6k\Omega}$

$5R_2 + 28k\Omega = 78.4k\Omega$

$5R_2 = 50.4$

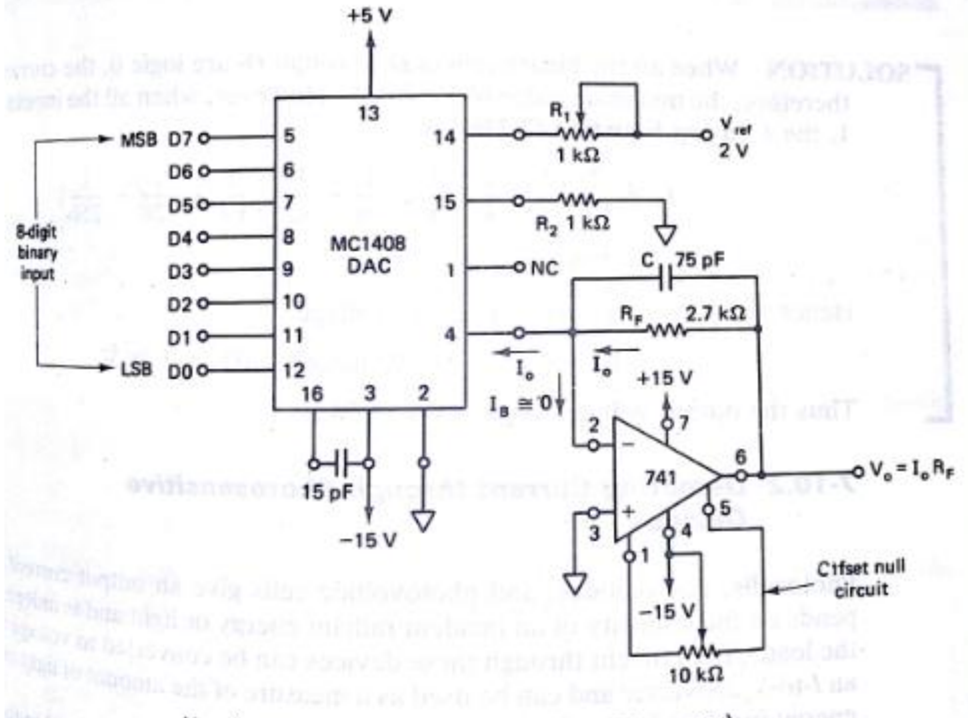
$R_2 = 10k\Omega$

2(b)voltage to current converters



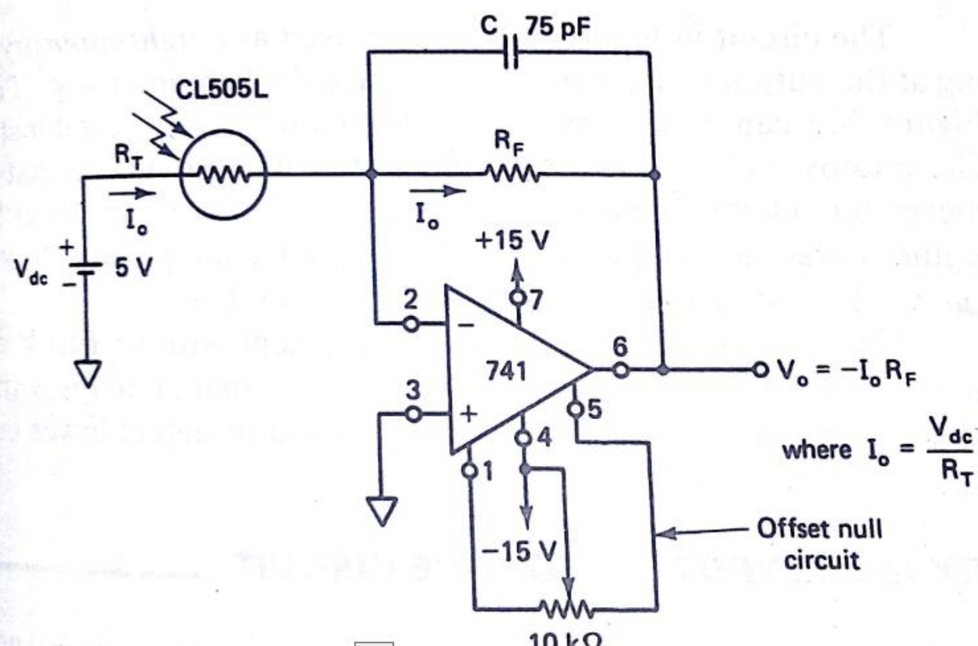
Current to voltage converters

$$I_o = \frac{V_{ref}}{R_1}\left(\frac{D_7}{2} + \frac{D_6}{4} + \frac{D_5}{8} + \frac{D_4}{16} + \frac{D_3}{32} + \frac{D_2}{64} + \frac{D_1}{128} + \frac{D_0}{256}\right) \quad (7\text{-}22a)$$



$$I_o = \frac{V_{ref}}{R_1}\left(\frac{D7}{2} + \frac{D6}{4} + \frac{D5}{8} + \frac{D4}{16} + \frac{D3}{32} + \frac{D2}{64} + \frac{D1}{128} + \frac{D0}{256}\right)$$

Figure 7–20 DAC using current-to-voltage converter.



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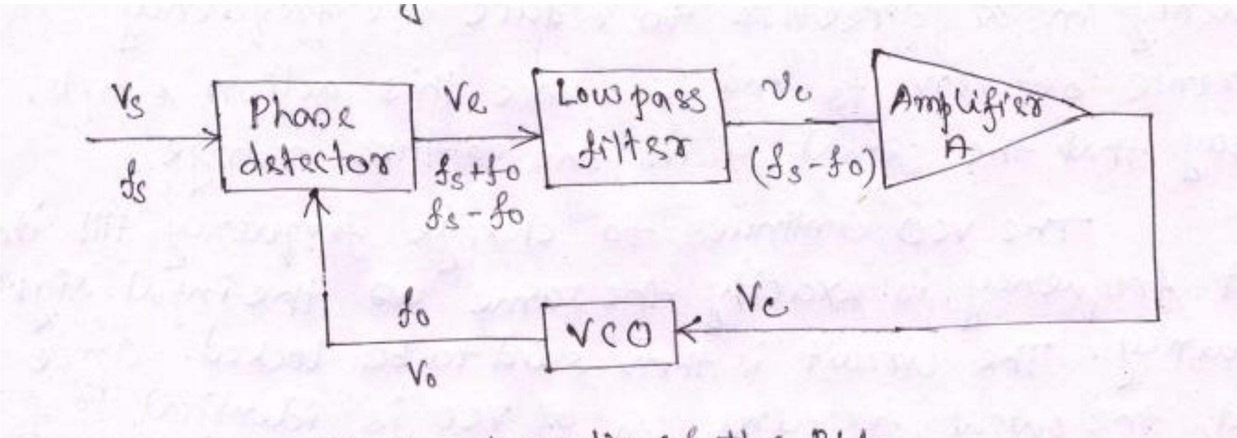
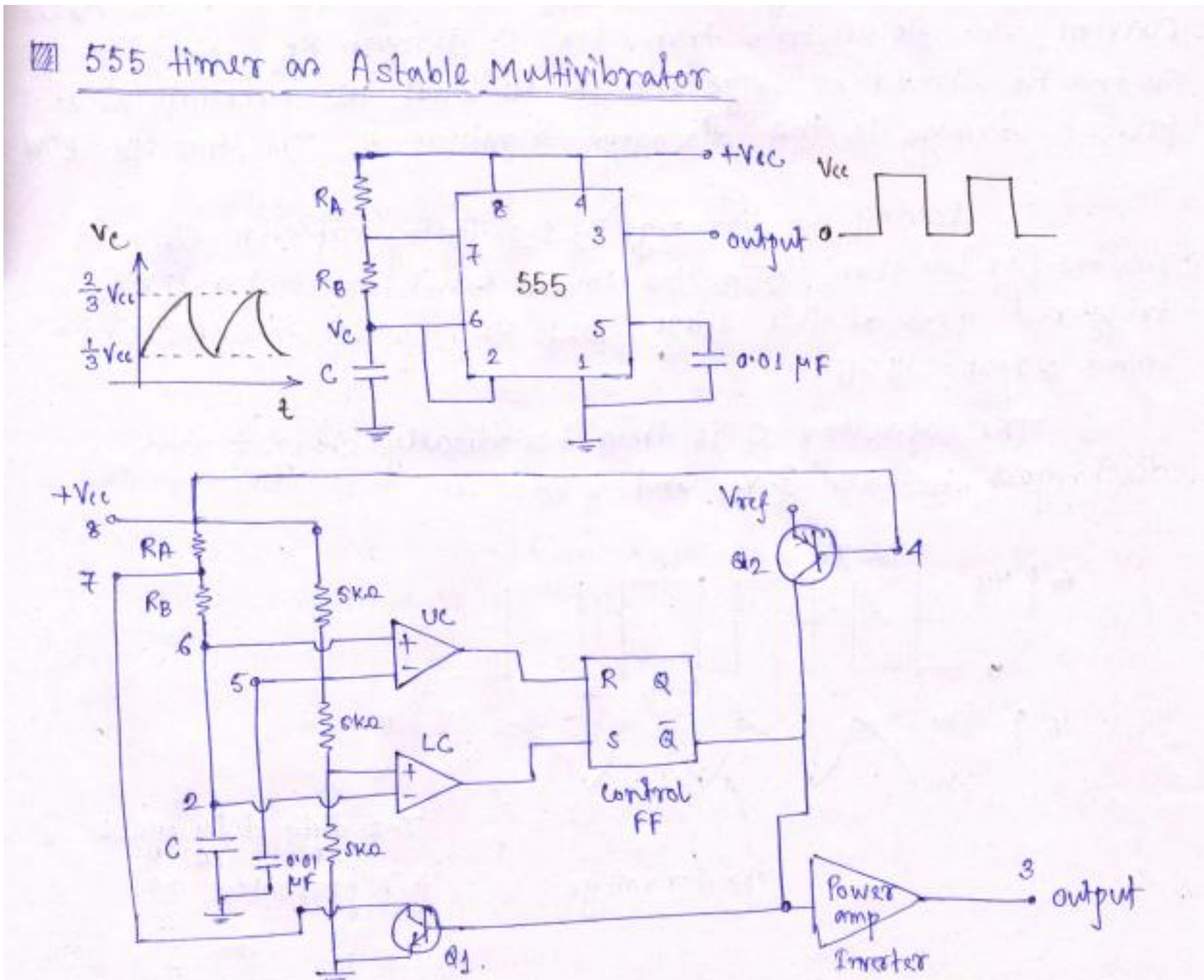


Block schematic of the PLL

4



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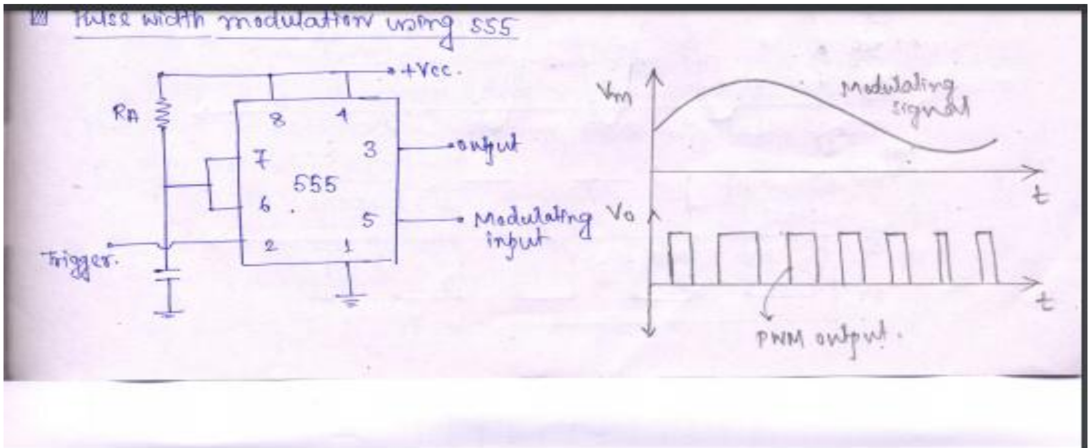
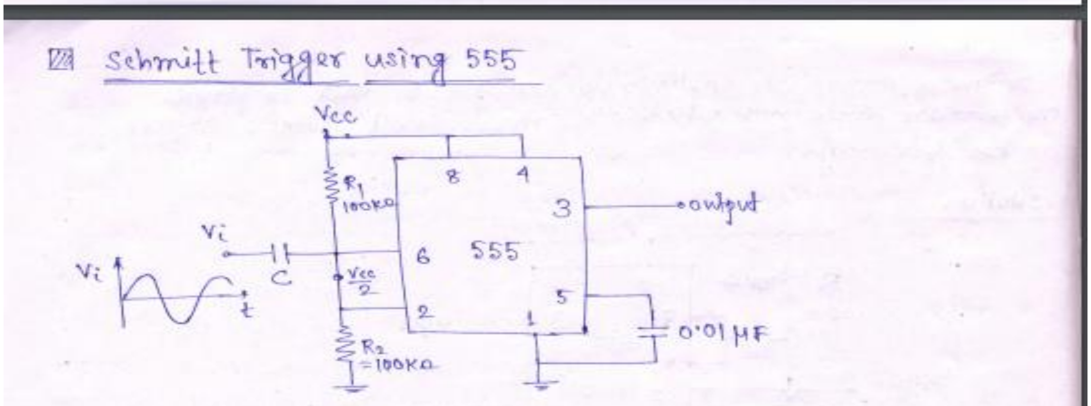

Pulse width modulation using 555
+Vcc
RA
8
4
7
3
output
555
6
5
Modulating input
2
1
Trigger
Vm
Modulating signal
t
Vo
t
PWM output


Schmitt Trigger using 555
Vcc
R1
100KΩ
8
4
3
output
Vi
6
555
Vi
C
Vcc/2
5
t
2
1
0·01 μF
R2
=100KΩ