(1)

model solution

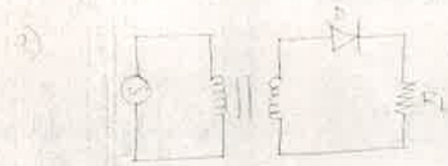
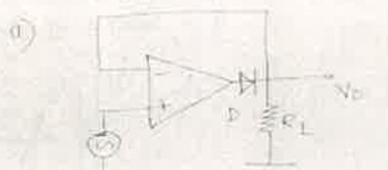
QP Code:- 23103

(3 Hours) [Total Marks: 80]

N.B.: (1) **Question No. 1 is compulsory.**
(2) **Solve any three questions from the remaining five.**
(3) **Figures to the right indicate full marks.**
(4) **Assume suitable data if necessary and mention the same in answer sheet.**

Q.1 Attempt any 4 questions: [20]

(A) How does precision rectifier differ from conventional rectifier?

ORDINARY RECTIFIER	PRECISION RECTIFIER
a) 	a) 
b) It can rectify s/g after 0.6V	b) It can rectify s/g of order of mV
c) Consists of only diode	c) Op amp and diode
d) It is used in power supply for radio, television & computers	d) It is useful for high precision s/g processing
e) Efficiency is less.	e) More than ordinary
f) Transformer is needed at i/p side	f) Doesn't use transform

(B) If the input to the ideal comparator shown in the Fig. 1(B) is a sinusoidal signal of 8 volt peak to peak without any DC component, then check whether the duty cycle of the output of comparator is 33.33% or 25% or 20%. Prove it.

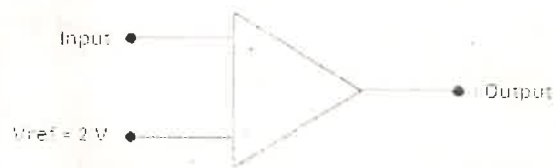
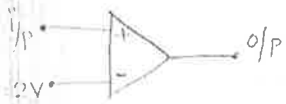


Fig. 1(B)

Q1.b)



$V_o = A(V_{id})$

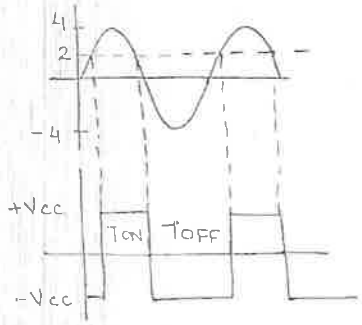
$= A(V^+ - V^-)$

If $V^+ > V^-$, then $V_o = A(+ve) = +V_{cc}$

If $V^- > V^+$, then $V_o = A(-ve) = -V_{cc}$.

Duty cycle $= \frac{T_{ON}}{T_{ON} + T_{OFF}} = \frac{T_{ON}}{T}$

$V_{in} = 4 \sin\omega t$



At $\omega t = x$, $V_{in} = 2$ volts.

$V_{in} = 4\sin\omega t$

$2 = 4\sin(x)$.

$\sin x = \frac{1}{2}$

$x = 30^\circ$

$T_{ON} = 180^\circ - 2 \times 30^\circ = 120^\circ$

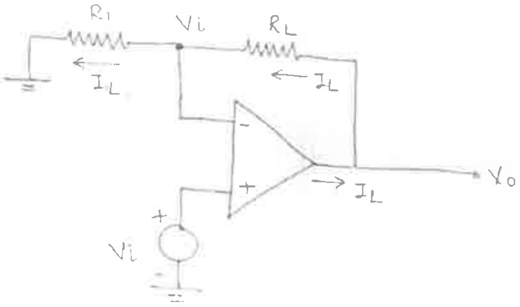
$T = 360^\circ$

Duty cycle $= \frac{120^\circ}{360} = \frac{1}{3} = 33.33\%$.

(C) With neat circuit diagram derive an expression for output current of a voltage to current converter with floating load.

→ The voltage to current converter accepts an i/p voltage V_i and gives an output current I_L.

→ The voltage to current converter with floating load is as shown below.



$V_i = I_L R_1$

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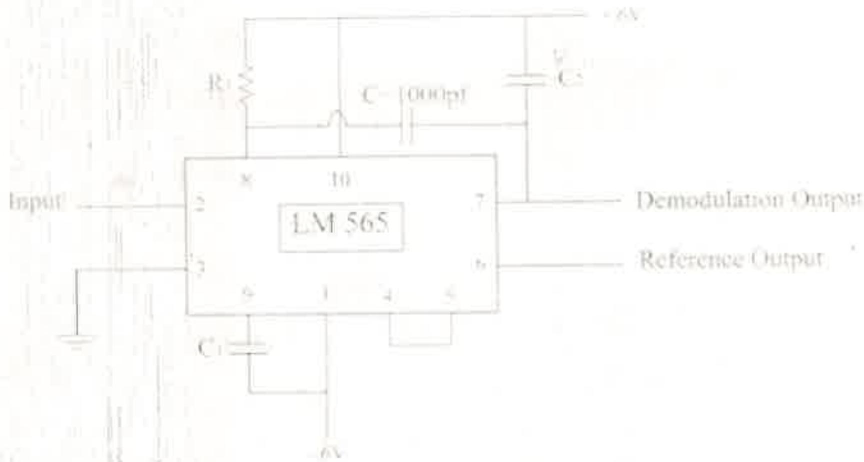
i.e. $I_L = \frac{V_i}{R_1}$

(D) With the help of a neat circuit diagram explain any one application of PLL 565.

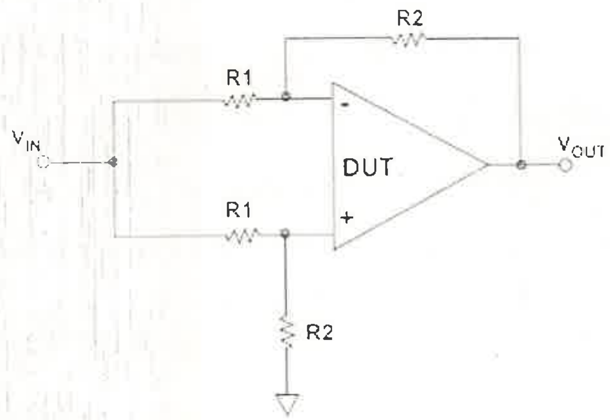
FM Detector



(E) What is CMRR? How to measure it practically?

"The ability of a differential amplifier to reject a common-mode signal is expressed by a ratio called Common Mode Rejection Ratio, denoted as CMRR".

CMRR is defined as the ratio of the differential voltage gain Ad to common mode voltage gain Ac. Ideally AC is zero. Hence, the ideal value of CMRR is ∞.

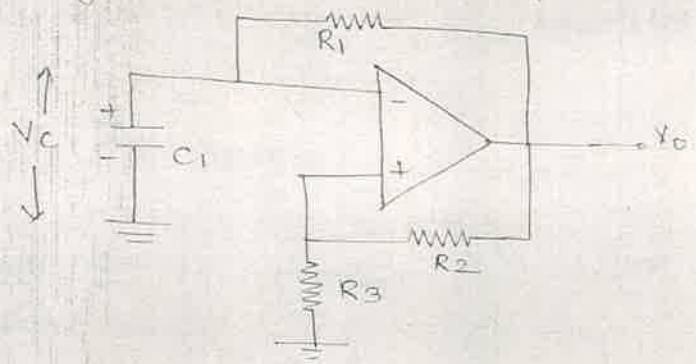


Q.2 (A) Draw the circuit diagram of a square and triangular waveform generator using opamps and explain its working with the help of waveforms. For variation in duty cycle what is the modification needed in the circuit. [10]

SQUARE WAVE GENERATOR USING OPAMP

→ Non sinusoidal waveform generators are
as relaxation oscillators

→ Fig below shows a square wave gen



→ In this ckt a fraction $\frac{R3}{R3+R2} = \beta$ of t
is fedback to the non-inverting i/p term

→ R_1 and C_1 forms the timing part

WORKING

→ Initially the voltage across the capacit
will be zero and the o/p of opamp
high (Assume o/p vltg is at +Vsat)

→ As a result the capacitor C1 starts
to positive voltage through R_1.

→ When C_1 is charged to a level so t
voltage at inverting terminal is abov
voltage at non-inverting terminal,
of opamp swings to -Vsat

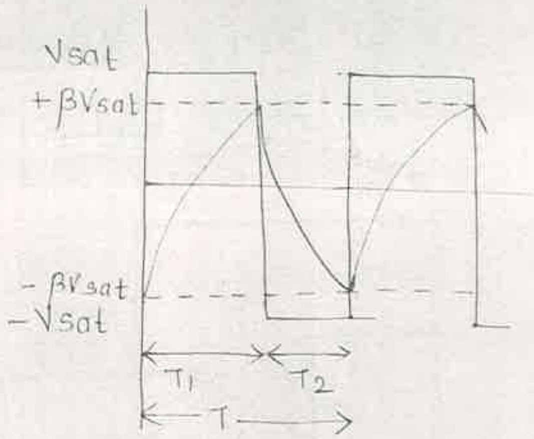
(05)

→ The capacitor quickly discharges throu
and starts charging to negative voltage

→ When C_1 is charged to a negative voltage
that the vltg at inv. i/p is more negati
than that of non inverting i/p, o/p of
opamp swings back to +Vsat.

→ Now the capacitor quickly discharges th
negative vltg thru R_1 and starts charging
positive vltg.

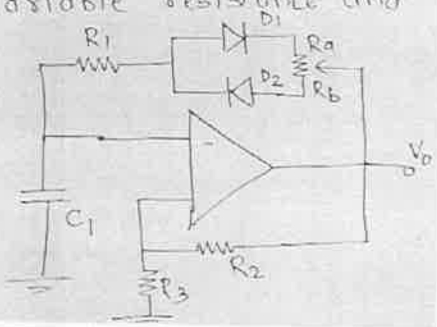
→ This cycle is repeated endlessly and th
is a continuous square wave swinging b
+Vsat & -Vsat



→ When V_c reaches +βVsat then the o/p
opamp switches to -Vsat.

→ The capacitor has charged to +βVsat. C
now begins to discharge

→ The duty cycle of the output wave can be changed replacing resistance R_1 by another circuit consisting of variable resistance and 2 diodes D_1 and D_2



$T_1 = (R+R_b)C \ln\left[\frac{1+\beta}{1-\beta}\right]$

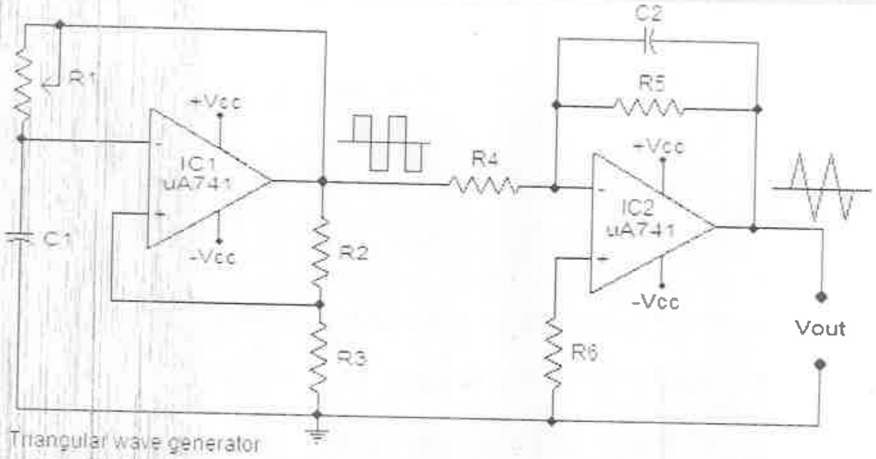
$T_2 = (R+R_a)C \ln\left[\frac{1+\beta}{1-\beta}\right]$

$T = T_1 + T_2$

$= (2R + R_a + R_b) C \ln\left[\frac{1+\beta}{1-\beta}\right]$

Duty cycle is given by $D = \frac{T_1}{T} = \frac{R}{2R}$

By varying Ra and Rb the duty cyc changed keeping freq constant.



Triangular wave generator

(B) With the help of a functional block diagram explain the working of voltage regulator LM317 to give an output voltage variable from 5 V to 10 V to handle maximum load current of 500 mA. [10]

(07)

For $V_o = 3V$

$$V_o = V_{ref} \frac{R_2}{R_1 + R_2}$$

$$3V = 7V \cdot \frac{R_2}{R_1 + R_2} \quad \text{(Taking } V_{ref} = 7V\text{)}$$

$$3R_1 + 3R_2 = 7R_2$$

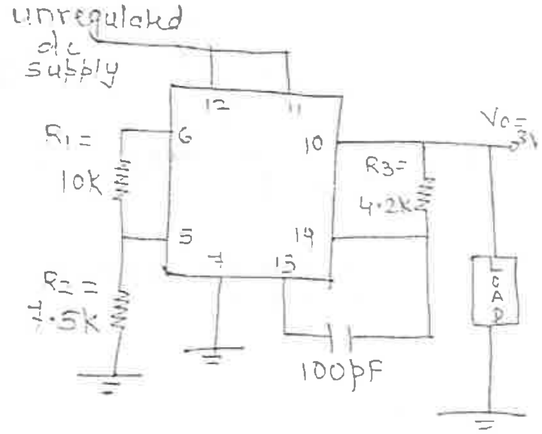
$$R_2 = \frac{3}{4} R_1$$

Let $R_1 = 10k\Omega$

$R_2 = 7.5k\Omega$

$R_3 = R_1 \| R_2$

$R_3 = 4.2k\Omega$



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$$\beta = \frac{V_o}{V_i} = \frac{RX}{RX + RX + RX + j(R^2 - X^2)}$$

$$= \frac{RX}{3RX + j(R^2 - X^2)}$$

$$\beta = \frac{1}{3}$$

For sustained oscillations

$A\beta = 1 \Rightarrow A = \frac{1}{\beta} = 3$

But $A = 1 + \frac{R_F}{R_1} \Rightarrow 1 + \frac{R_F}{R_1} = 3$

Let $C = 0.05 \mu F$

$R = 3.183 k\Omega$

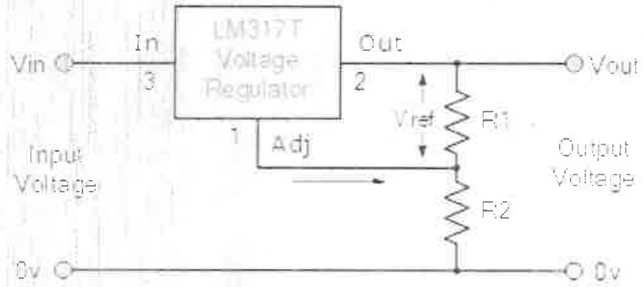
Let $R_1 = 12 k\Omega$

$\therefore 1 + \frac{R_F}{R_1} = 3 \quad (\because A\beta = 1 \;\&\; \beta = 1/3$

$R_F = 24 k\Omega$

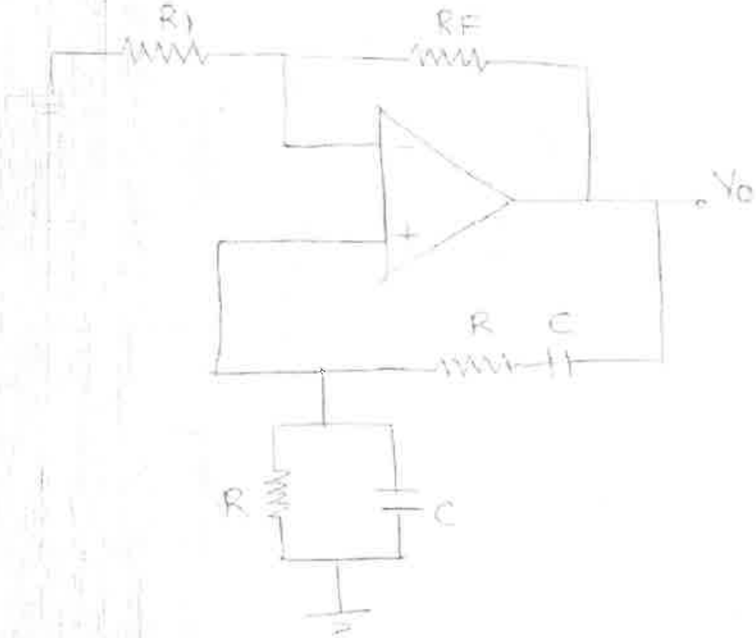
(B) Design a voltage regulator using IC 723 to give V_o = 3 V to 37 V and output current of 2A. [10]

09



$$V_{OUT} = 1.25\left(1+\frac{R_2}{R_1}\right)$$

Q.3 (A) Draw a neat circuit diagram of a Wein bridge oscillator using opamp. Derive its frequency of oscillation. What are the values of *R* and *C* if its frequency of oscillation is 1 kHz? [10]



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For $V_o = 37V$

$$V_o = V_{ref}\left(1 + \frac{R_f}{R_2}\right)$$

$$V_o = 7\left(1 + \frac{R_f}{R_2}\right)$$

$$37 = 7\left(1 + \frac{R_f}{R_2}\right)$$

$$\frac{37}{7} = 1 + \frac{R_1}{R_2}$$

$$5.286 = 1 + \frac{R_1}{R_2}$$

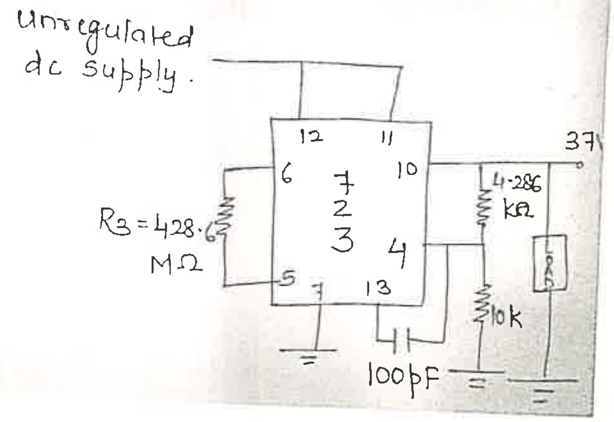
$$R_1 = 4.286 R_2$$

Let $R_2 = 10\,k\Omega$.

$$R_1 = 42.86\,k\Omega$$

$$R_3 = R_1 \cdot R_2$$

$$= 428.6\,M\Omega$$



Q.4 (A) Design a second order Butterworth high pass filter for cut off frequency of 1 kHz and pass-band gain of AF=2. [10]

P.T.O.

Let $R_1 = R_2 = R$ & $C_1 = C_2 = C$

$$f_0 = \frac{1}{2\pi RC}$$

Let $C = 0.01\,\mu F$

$$R = R_1 = R_2 = \frac{1}{2\pi f_0 C} = \frac{1}{2\pi \times 1 \times 10^3 \times 0.01 \times 10^{-6}}$$

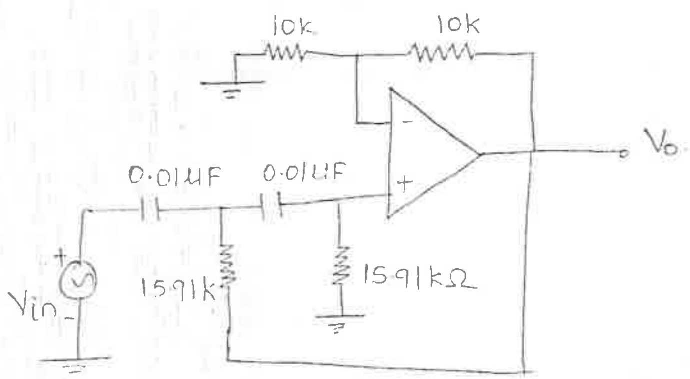
$R_1 = R_2 = 15.91\,k\Omega$

$k = 2$

$$k = 1 + \frac{R_4}{R_3}$$

Let $R_3 = 10K$

$\therefore\ R_4 = 10\,k\Omega$



(B) Design a counter for counting a sequence 3, 4, 5, 6…12, 3... using IC MSI 74163. The pin terminology and functionality of IC MSI 74163 is given in Fig. 4(B). [10]

	Inputs				Current State				Next State			
	CLR	LD	ENT	ENP	QD	QC	QB	QA	QD*	QC*	QB*	QA*
clear	0	x	x	x	x	x	x	x	0	0	0	0
load	1	0	x	x	x	x	x	x	D	C	B	A
hold	1	1	0	x	x	x	x	x	QD	QC	QB	QA
hold	1	1	x	0	x	x	x	x	QD	QC	QB	QA
	1	1	1	1	0	0	0	0	0	0	0	1
	1	1	1	1	0	0	0	1	0	0	1	0
	1	1	1	1	0	0	1	0	0	0	1	1
	1	1	1	1	0	0	1	1	0	1	0	0
	1	1	1	1	0	1	0	0	0	1	0	1

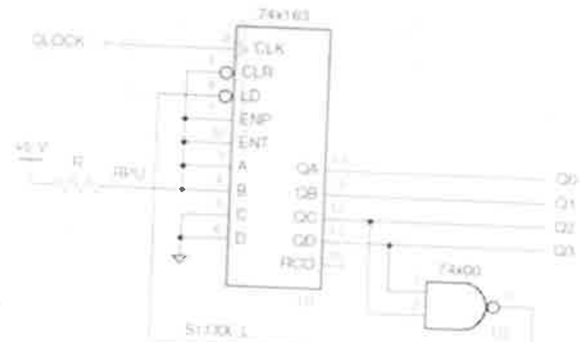
Fig. 4(B)

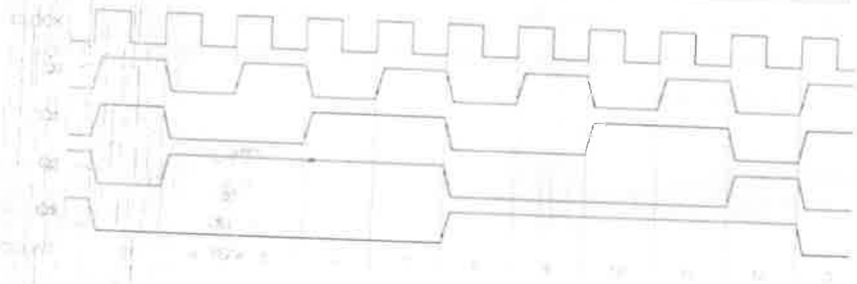
→ Load 0011 (3) after count = 12

→ 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 3, 4, ...

→ Divide by 10 counter

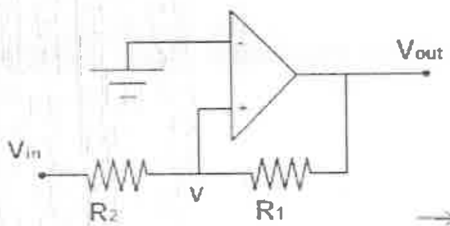
Counting from 3 to 12

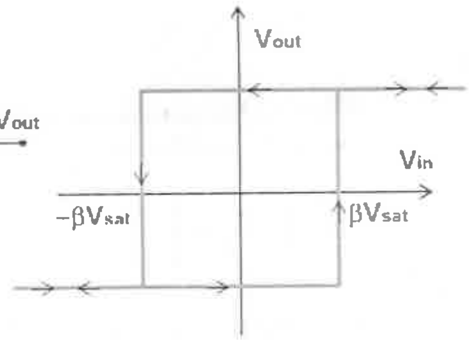




Q.5 (A) With the help of a neat diagram and voltage transfer characteristics explain the [10] working of a non-inverting Schmitt trigger. Derive the expressions for its threshold levels.

In this case, again the feedback is given at non-inverting terminal. The inverting terminal is grounded and the input voltage is connected to non-inverting input. **Fig.below**, shows an non-inverting schmitt trigger circuit.





To analyze the circuit behaviour, let us assume the output is negatively saturated. Then the feedback voltage is also negative ($-V_{sat}$). Then the feedback voltage is also negative. This feedback voltage will hold the output in negative saturation until the input voltage becomes positive enough to make voltage positive.

$$V_+ = \frac{(-V_{sat} - v_{in})}{R_1 + R_2} R_2 + v_{in}$$

$$= \frac{-V_{sat} R_2}{R_1 + R_2} + \frac{v_{in} R_1}{R_1 + R_2}$$

$$= \frac{R_1}{R_1 + R_2}(-R_2 V_{sat} + R_1 v_{in})$$

$$= \frac{R_1}{R_1 + R_2}\left(-\frac{R_2 V_{sat}}{R_1} + v_{in}\right)$$

When v_{in} becomes positive and its magnitude is greater than $(R_2 / R_1)\, V_{sat}$, then the output switches to $+V_{sat}$. Therefore, the UTP at which the output switches to $+V_{sat}$, is given by

$$UTP = \left(\frac{R_2 V_{sat}}{R_1}\right)$$

Simillarly, when the output is in positive saturation, feedback voltage is positive. To switch output states, the input voltage has to become negative enough to make. When it happens, the output changes to the negative state from positive saturation to negative saturation voltage negative.

$$V_+ = \frac{(V_{sat} - v_{in})}{R_1 + R_2} R_2 + v_{in}$$

$$= \frac{V_{sat} R_2}{R_1 + R_2} + \frac{v_{in} R_1}{R_1 + R_2}$$

$$= \frac{R_1}{R_1 + R_2} (R_2 V_{sat} + R_1 v_{in})$$

$$= \frac{R_1}{R_1 + R_2} \left(\frac{R_2 V_{sat}}{R_1} + v_{in} \right)$$

When v_{in} becomes negative and its magnitude is greater than $R_2 / R_1\ v_{sat}$, then the output switches to $-v_{sat}$. Therefore,

$$LTP = \left(-\frac{R_2 V_{sat}}{R_1} \right)$$

The difference of UTP and LTP gives the hysteresis of the Schmitt trigger.

$$V_{hys} = UTP - LTP$$

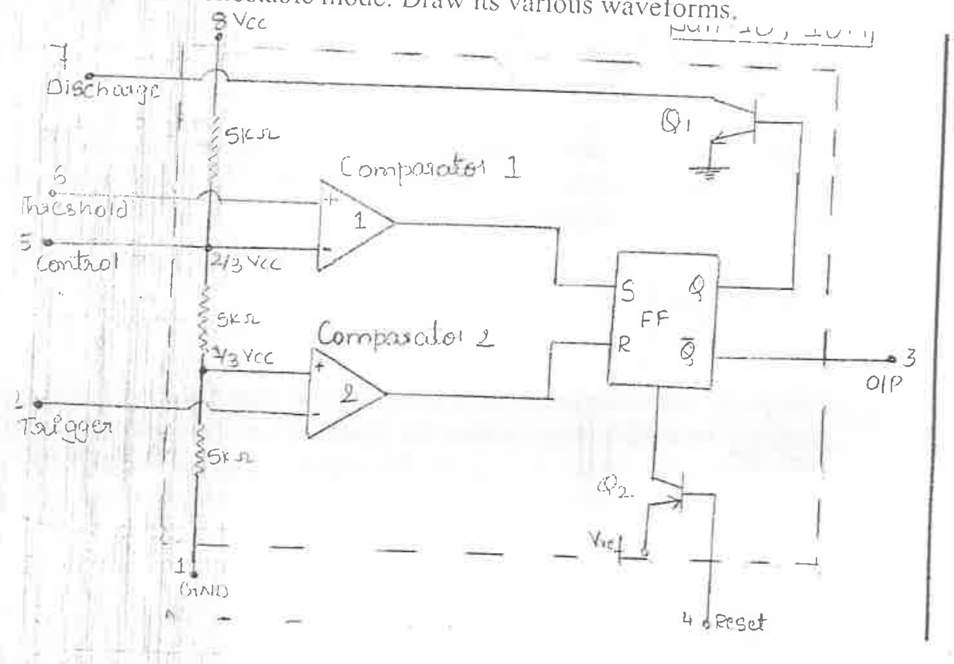
$$= 2\left(\frac{R_2}{R_1} \right) V_{sat}$$

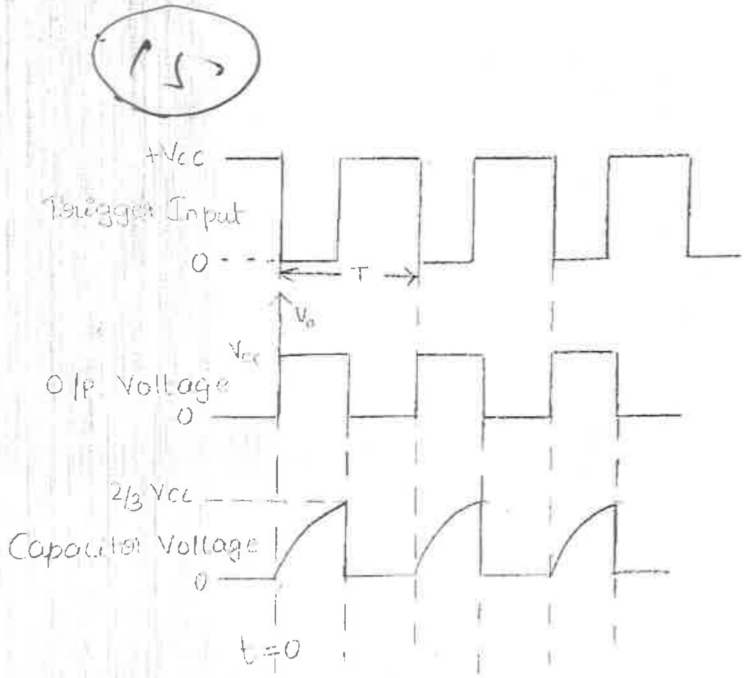
$$= 2\beta V_{sat}$$

In non inverting Schmitt trigger circuit, the β is defined as

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

(B) Draw and explain the functional block diagram of IC 555 and explain its operation in monostable mode. Draw its various waveforms. [10]





Q.6 Short notes on: (Attempt any two) [20]

(A) Voltage to frequency converter.

(B) IC 74181 Arithmetic Logic Unit.

16

(5) When the Mode Control Input is Low, the device performs arithmetic operations on the two 4 bit words.

(6) Carry lookahead can be provided to the high speed capability over extremely high word lengths.

(7) [illegible] can be used with either Active Low inputs producing active Low outputs or the active HIGH inputs producing active HIGH outputs.

(8) ALU is controlled by four Function Select Inputs (S_0 ... S_3)

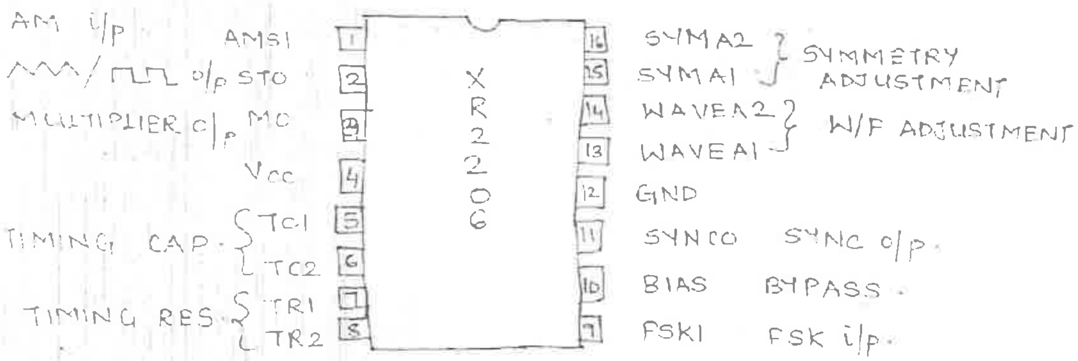
(C) Waveform generator XR 2206.

→ XR-2206 from Exar is a function generator which generates triangular and square w/f.

→ It consists of a logarithmic wave shaper for converting triangular wave to sinewave.

→ It is used in w/f generation, sweep generation, AM/FM generation, V/F conversion, FSK generation and VCO circuit of Phase locked loop.

PIN DIAGRAM.



BLOCK DIAGRAM.