EE-230 - 2025

Mid-Sem Solutions

(1) checking Individual opamp of TL082.

By Making Voltage Buffer. (2+2 = 4M)

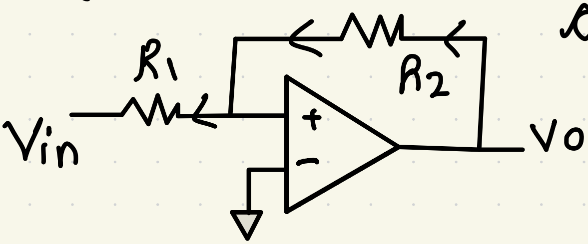
(2) (1) Analysis of Sub. circuit 1 (5M)

(i) +ve feedback (0.5M)

(ii) NON - Inverting schmitt trigger (1M)

(iii) No Virtual ground concept is Not Applicable due to +ve feedback (0.5M)

(iv)



considering $V_o = +V_{sat}$ for LTP calculation

$$V^+ = \frac{R_1 V_o}{R_1 + R_2} + \frac{V_{in} \times R_2}{R_1 + R_2}$$

For opamp to Saturate to $-V_{sat}$ $V^+ < V^-$

i.e. $R_1 V_o + R_2 V_{in} < 0$

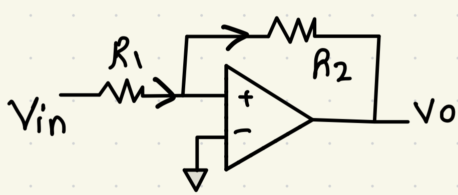
$$\boxed{V_{in_{LTP}} < -\frac{R_1}{R_2} V_{sat}}$$

(0.5M) For derivation + correct Exp.

Similarly for UTP

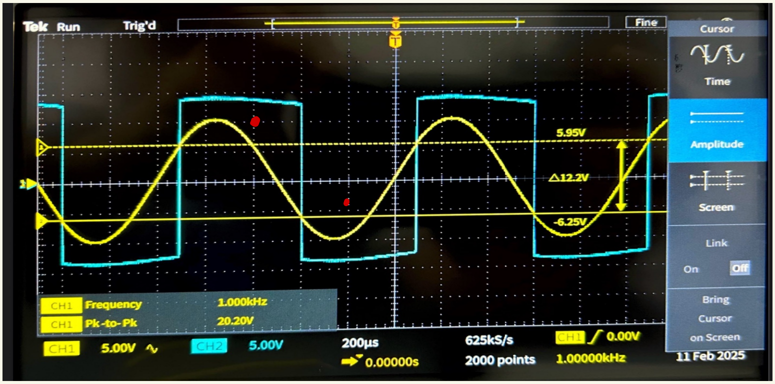
$$\boxed{UTP = R_1/R_2 \, V_{sat}}$$

(0.5M)



(v) They Need to Show the V_{o1} & Vin waveform Simultaneously on DSO. & UTP & LTP using cursor & Verify the Theoritical & practical Values.

UTP → (5.7V to 6.8V)



(3M)

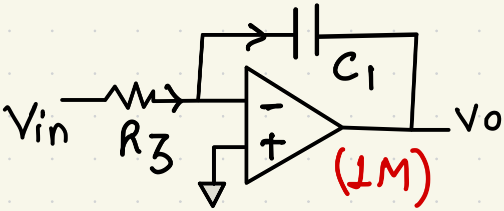
② Analysis of Sub circuit 02 (5M)

(i) –ve feedback circuit. (0.5M)

(ii) Integrator circuit (1M)

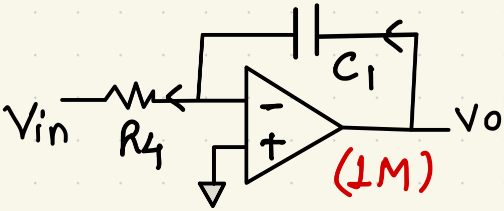
(iii) Yes, As long as opamp doesn't Saturate Virtual ground concept is Applicable. (0.5M)

(iv) (i)



(1M)

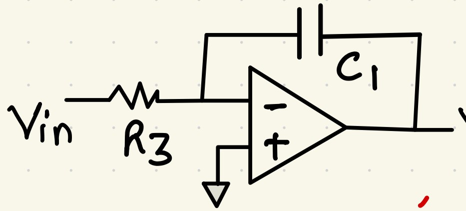
(ii)



(1M)

(iii) Vout in terms of Vin.

When diode D_1 is ON.



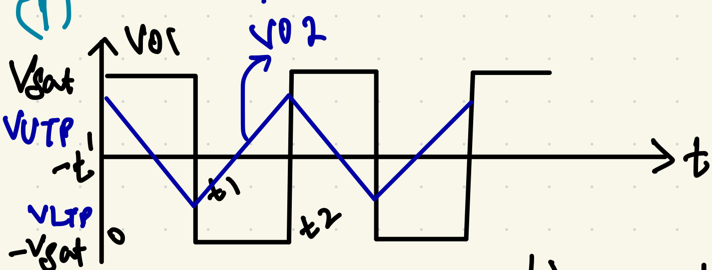
$$V_o = \boxed{-\frac{1}{R_3 C_1}\int V_{in}(t)\,dt}$$ ½M

Similarly, when diode D_2 is ON

$$V_0 = -\frac{1}{R_4 C_1}\int V_{in}(t)\,dt$$ ½M

3) Analysis of overall circuit (8M)

(i)



2M

$$V_{o2} = -\frac{R_1}{R_2}V_{sat} + \frac{1}{R_4 C_1}\int_0^{t_1} V_{sat}\,dt$$

at $t = t$

$$\frac{R_1}{R_2}V_{sat} = -\frac{R_1}{R_2}V_{sat} + \frac{V_{sat}t_1}{R_4 C_1}$$

$$\boxed{\frac{2R_1}{R_2} = \frac{t_1}{R_4 C_1}} \quad \text{— (1)}$$

(1.5M)

Similarly

1.5M

$$\boxed{\frac{2R_1}{R_2} = \frac{t_2 - t_1}{R_3 C_1}} \quad \text{— (2)}$$

t_2 = Time period

Solving (1) & (2)

$$\frac{2R_1}{R_2}(R_3 + R_4)C_1 = t_2$$

(1M)

$$\boxed{f = \frac{1}{T_2} = \frac{1}{2(R_3+R_4)C_1} \times \frac{R_2}{R_1}}$$

(iii) When $R_3 = R_4$ then o/p will be Triangular wave. (1M)

(iv) The diodes D_1 & D_2 will the change the duty cycle of Square wave when connected in closed loop Fashion. (0.5M)

No, we can't get Sawtooth without diodes (0.5M).

Second Part: Determining component values (2M)

$\boxed{R_3 + R_4 \simeq 7.33k}$

They can choose Any Value of R3 & R4 But the $R_3 + R_4 \simeq 7.33 k\Omega$. 2M

Hardware Implementation (5M)

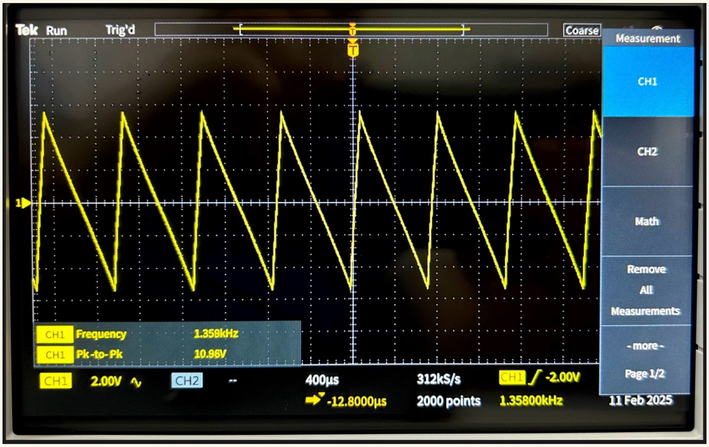
Circuit Building on Breadboard (2M)

They will show the Sawtooth waveform & Triangular waveform ($R_3 = R_4$)

$\boxed{\text{Freq range: } 1.3\,\text{kHz} - 2.5\,\text{kHz}}$

Tabulation of frequency & Vpp. - (1M)

Reference o/p



They will show the Sawtooth & Triangular wave on DSO. (2M)

*Note:- Frequency Expression in terms of VUTP & VLTP is also considered.