Analog Electronics - LVII

Lakshya GATE 2023: Course on Analog Electronics for ECE EE IN

Siddharth Sabharwal • Lesson 79 • July 16, 2022


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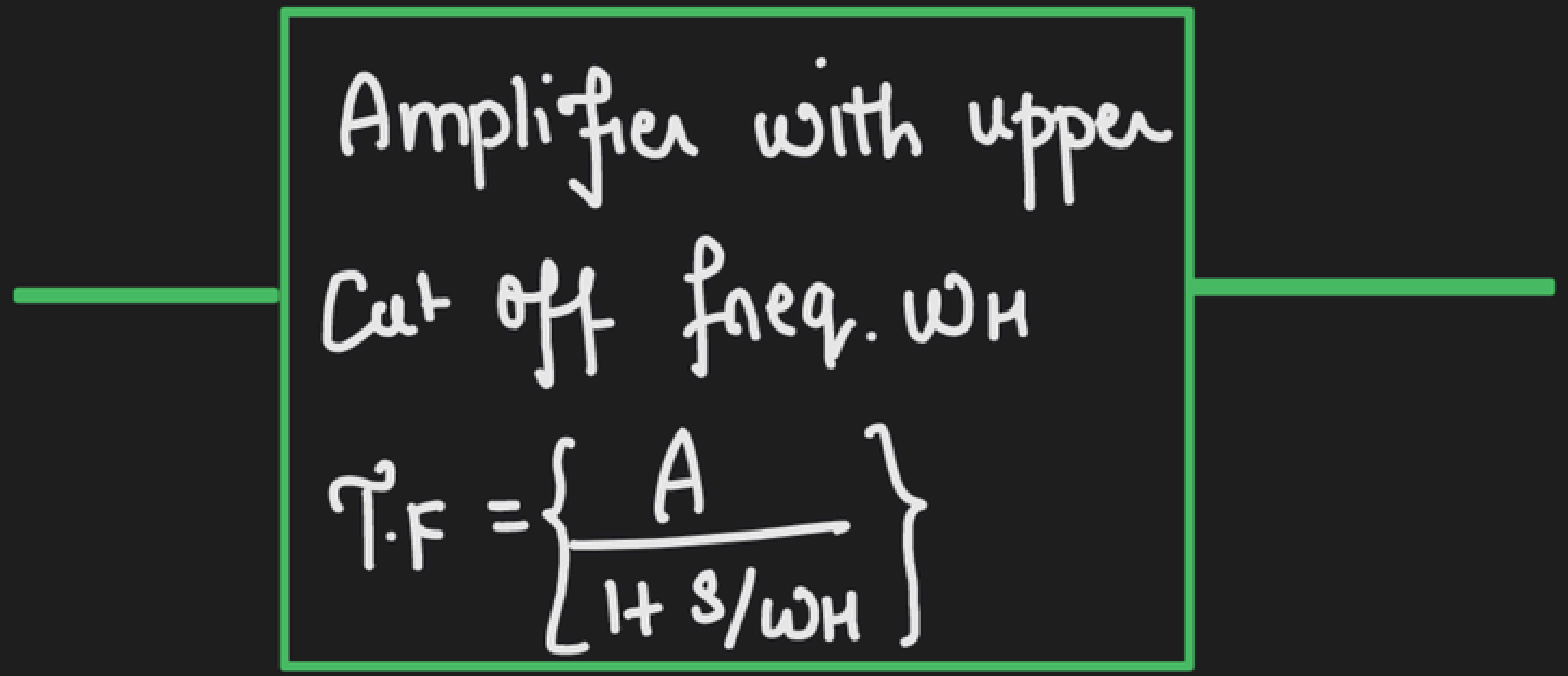
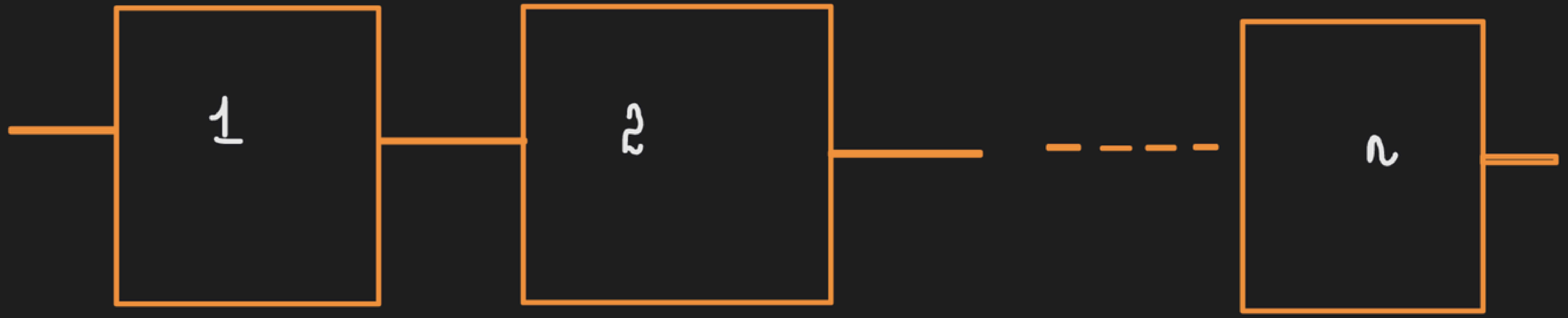
• Cascading of Amplifiers.



we have Connected n Amplifier in Cascade



The overall T.F will be

$$\frac{A^n}{\left[1+ s/\omega_H\right]^n}$$

→ @ Zero freq, magnitude is A^n.

@ ω_H^* magnitude $= \frac{A^n}{\sqrt{2}}$

$$\frac{A^n}{\left\{1+ \frac{\omega_H^{*2}}{\omega_H^2}\right\}^{n/2}} = \frac{A^n}{\sqrt{2}}$$

→ new ω_H^* will be the freq where magnitude is $\frac{A^n}{\sqrt{2}}$

$$\left\{1+\frac{\omega_H^{*2}}{\omega_H^2}\right\}^{n/2} = 2^{1/2}$$

$$\frac{\omega_H^{*2}}{\omega_H^2} = 2^{1/n} - 1$$

$$\boxed{\omega_H^* = \sqrt{2^{1/n}-1}\;\omega_H.}$$

We have connected 'n' identical devices together

Let T.F of a system is $\left\{ \dfrac{A \; s/\omega_L}{1 + s/\omega_L} \right\}$

We connect n identical Amplifier together,

$$\frac{A^n (s/\omega_L)^n}{(1 + s/\omega_L)^n}$$

@ new value of ω_L^* magnitude is $\dfrac{A^n}{\sqrt{2}}$

$$\frac{\cancel{An}\left(\omega_L^*/\omega_L\right)^n}{\left(1+\frac{\omega_L^{*2}}{\omega_L^2}\right)^{n/2}} = \frac{\cancel{An}}{\sqrt{2}}$$

$$\sqrt{2}\left(\frac{\omega_L^*}{\omega_L}\right)^n = \left\{1+\frac{\omega_L^{*2}}{\omega_L^2}\right\}^{n/2}$$

$$2\left(\frac{\omega_L^{*2}}{\omega_L^2}\right)^n = \left(1+\frac{\omega_L^{*2}}{\omega_L^2}\right)^n$$

$$2^{1/n} \frac{\omega_L^{*2}}{\omega_L^2} = 1 + \frac{\omega_L^{*2}}{\omega_L^2}$$

$$\left(2^{1/n} - 1\right) \omega_L^{*2} = \omega_L^2$$

$$\boxed{\omega_L^{*} = \frac{\omega_L}{\sqrt{2^{1/n} - 1}}}$$

- If we Cascade n identical Amplifiers ⇒

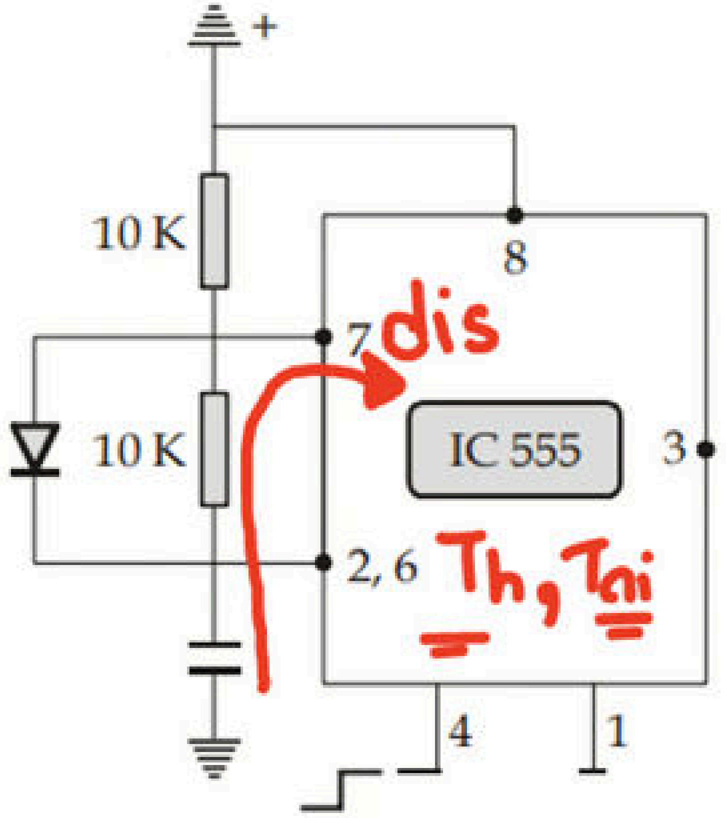
$$\omega_H^* = \sqrt{2^{1/n} - 1}\ \omega_H \qquad \omega_L^* = \frac{\omega_L}{\sqrt{2^{1/n} - 1}}$$

Q

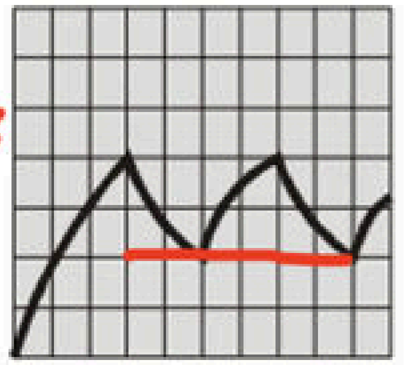
IC 555 in the figure is configured as an $\boxed{\text{astable}}$ multivibrator. It is enabled to oscillate at $t = 0$ by applying a high input to pin 4. The pin description is 1 and 8-supply, 2-trigger, 4-resel, 6-threshold, 7-discharge. The waveform appearing across the capacitor starting from $t = 0$, as observed on a storage CRO is

RC= 10KC

RC= 10K.C



(a)



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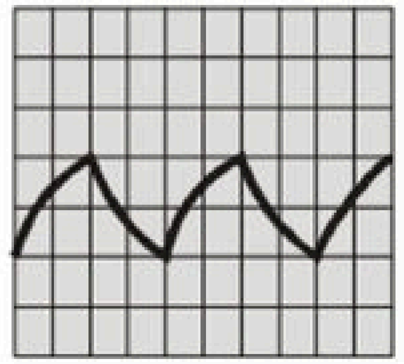
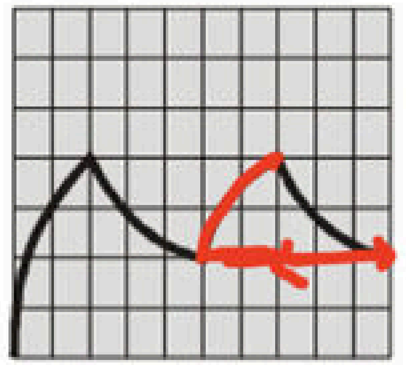
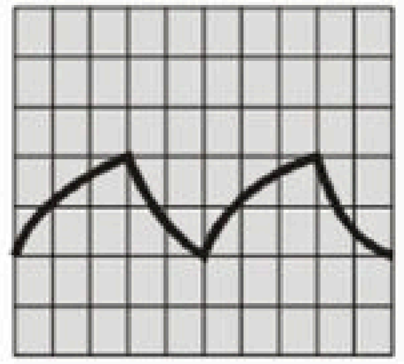


(c)

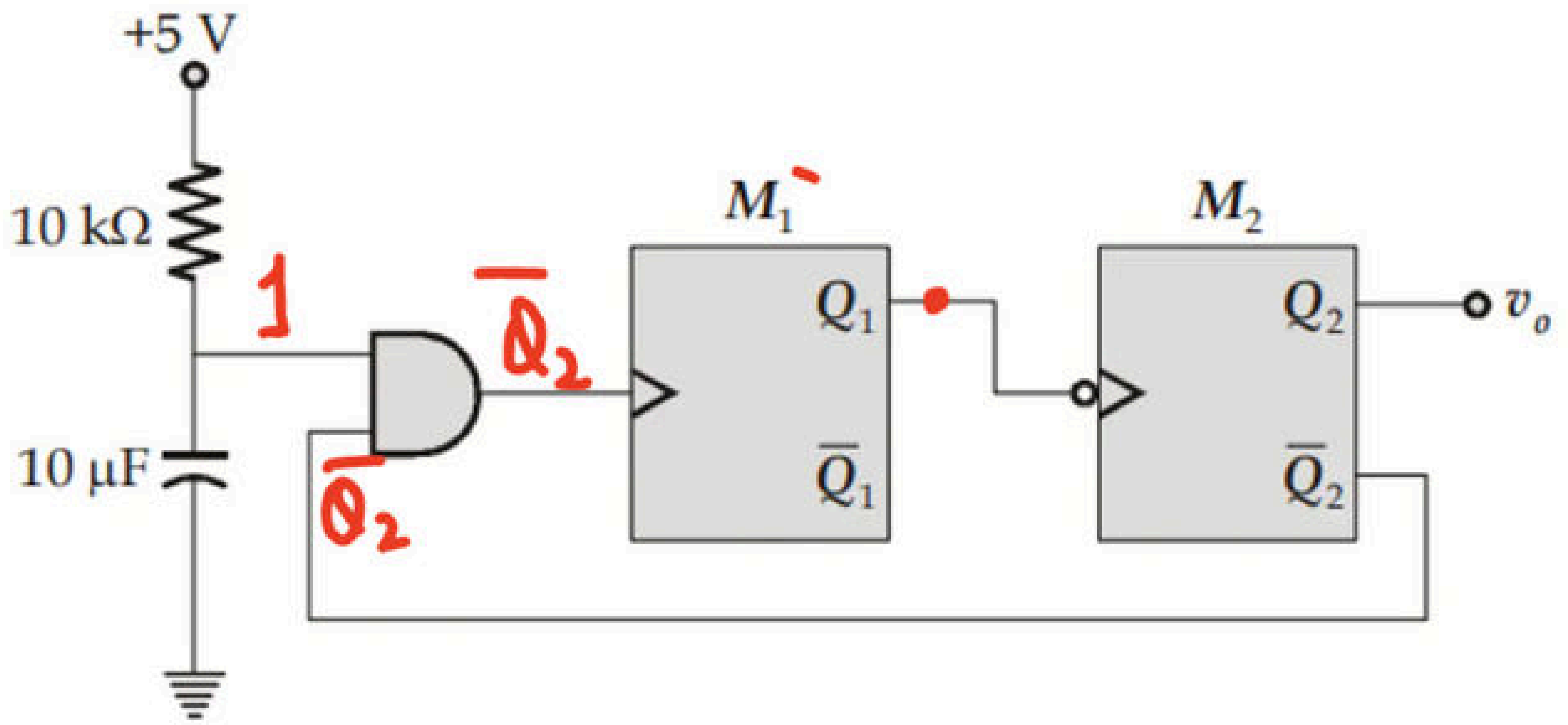


(d)



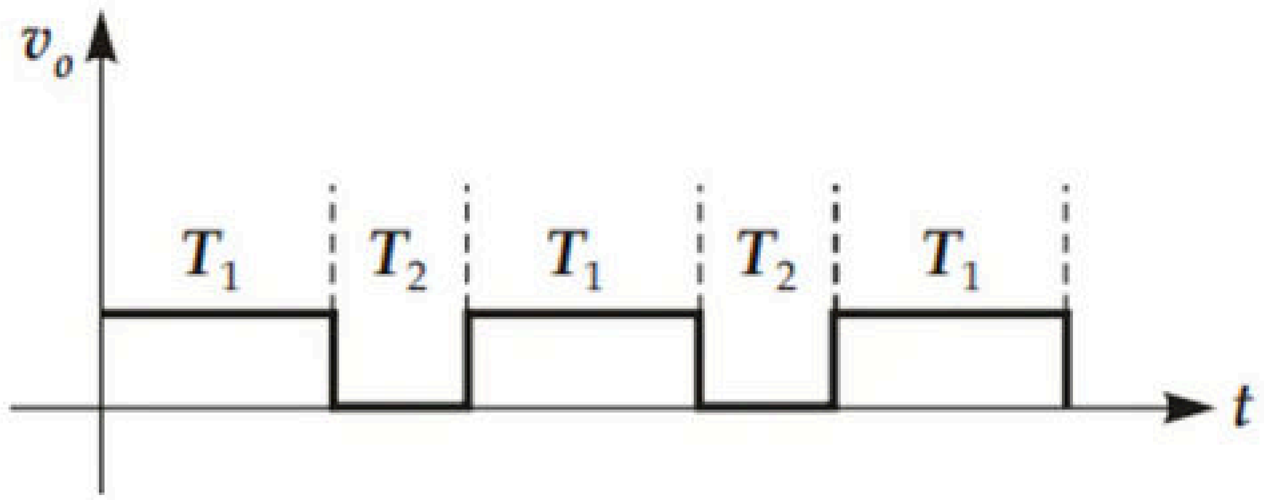
[EE-2007 : 2 Marks]

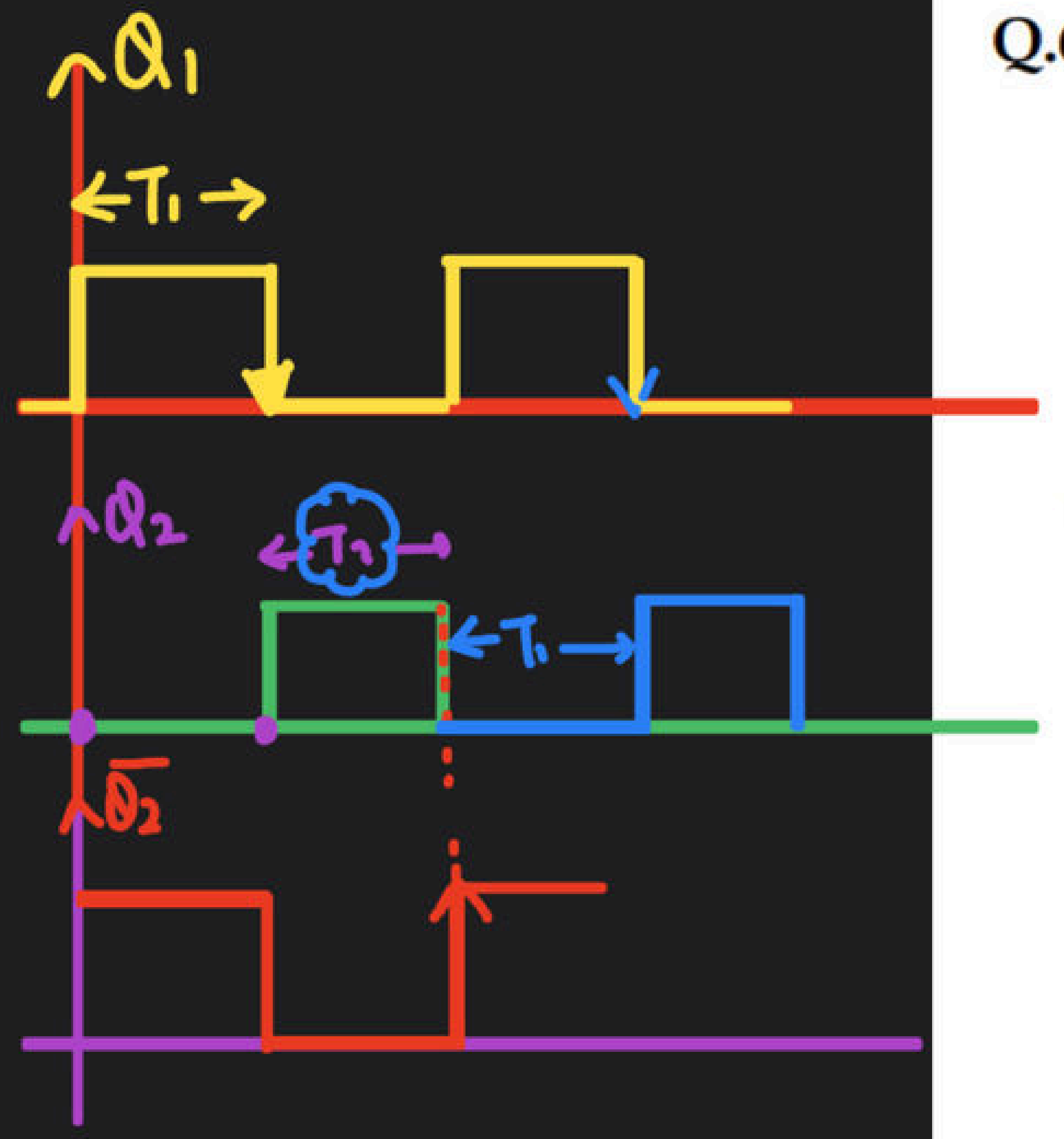
Q.6 Two monoshot multivibrators, one positive edge triggered (M_1) and another negative edge triggered (M_2), are connected as shown in figure.



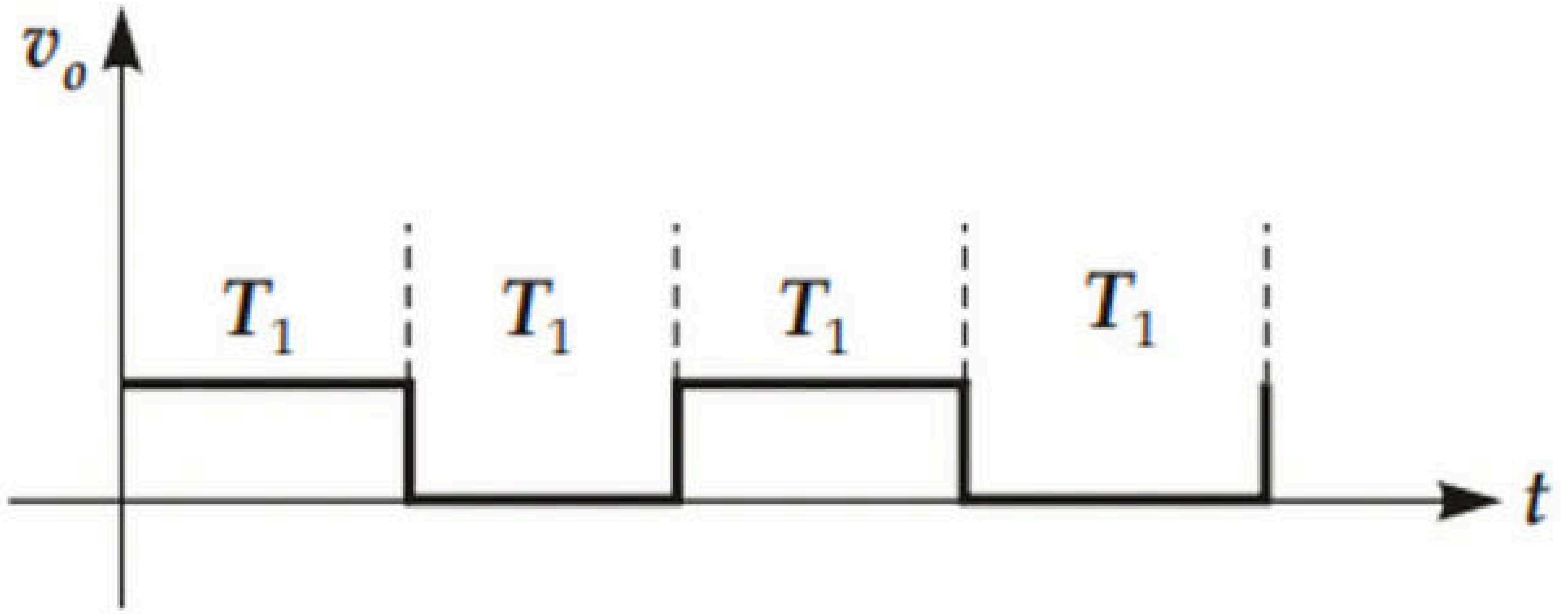
The monoshots M_1 and M_2 when triggered produce pulses of width T_1 and T_2 respectively, where $T_1 > T_2$. The steady-state output voltage V_o of the circuit is

(a)

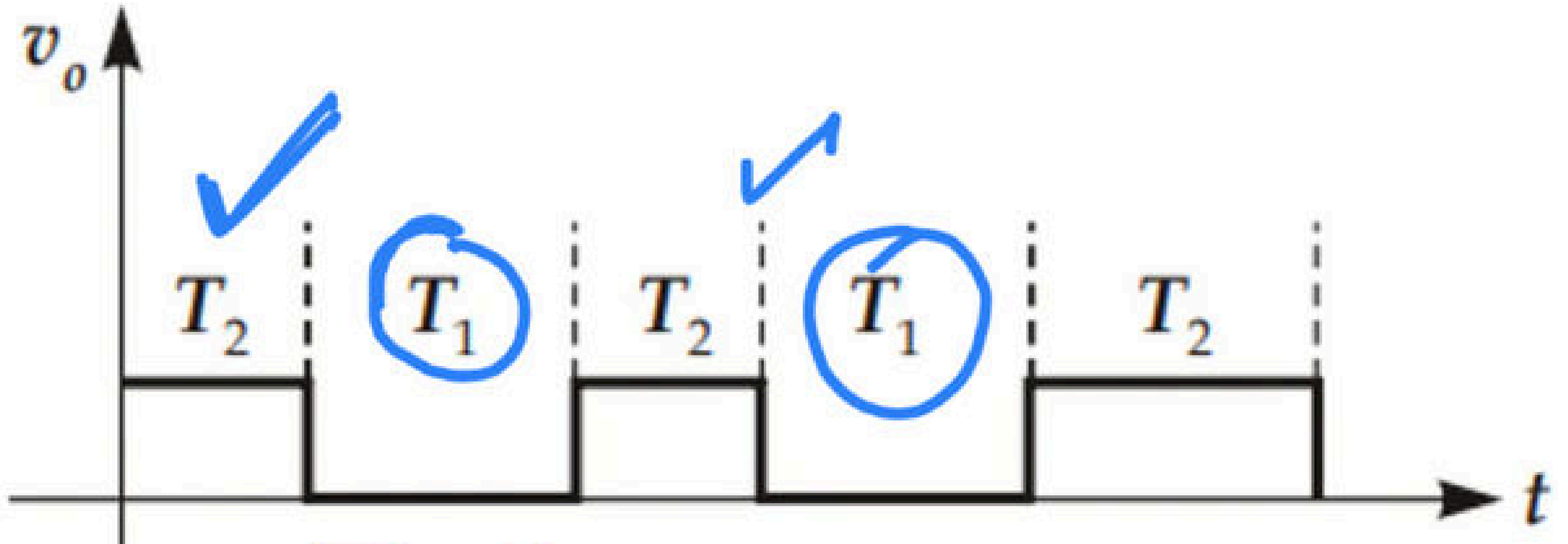




(b)

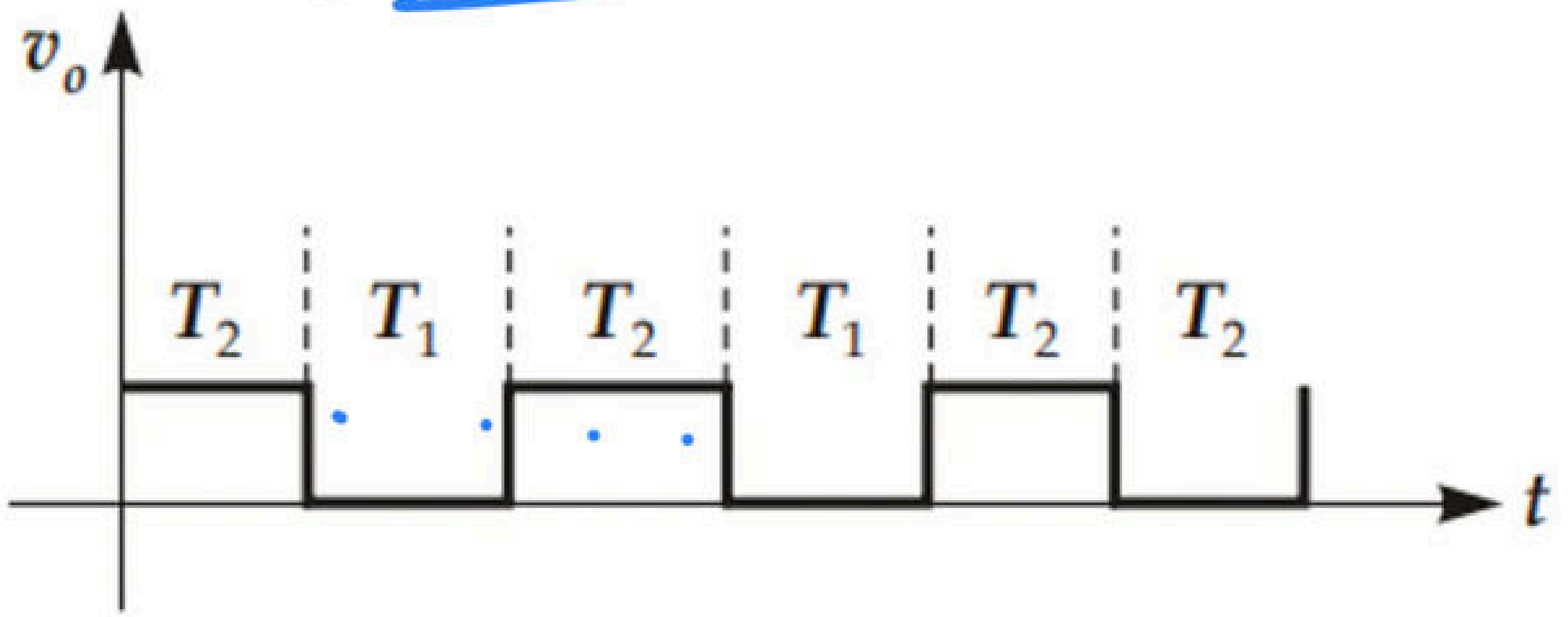


(c)



$T_1 > T_2$

(d)

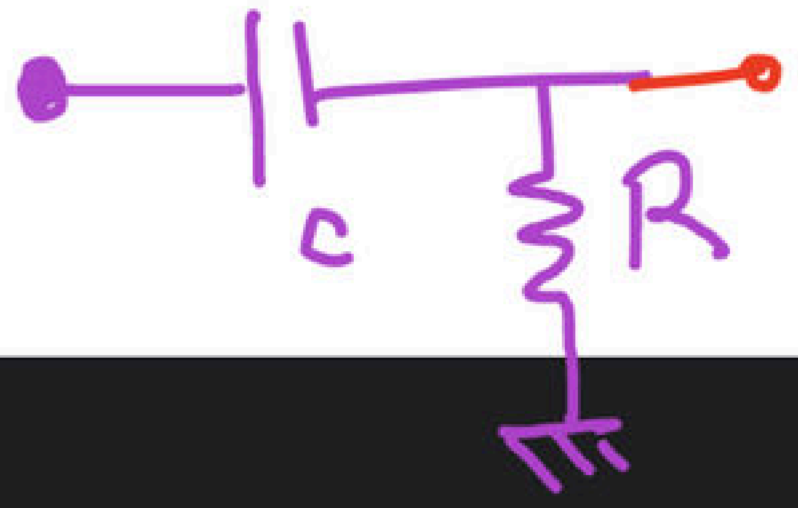


[EE-2014 : 2 Marks]

Q

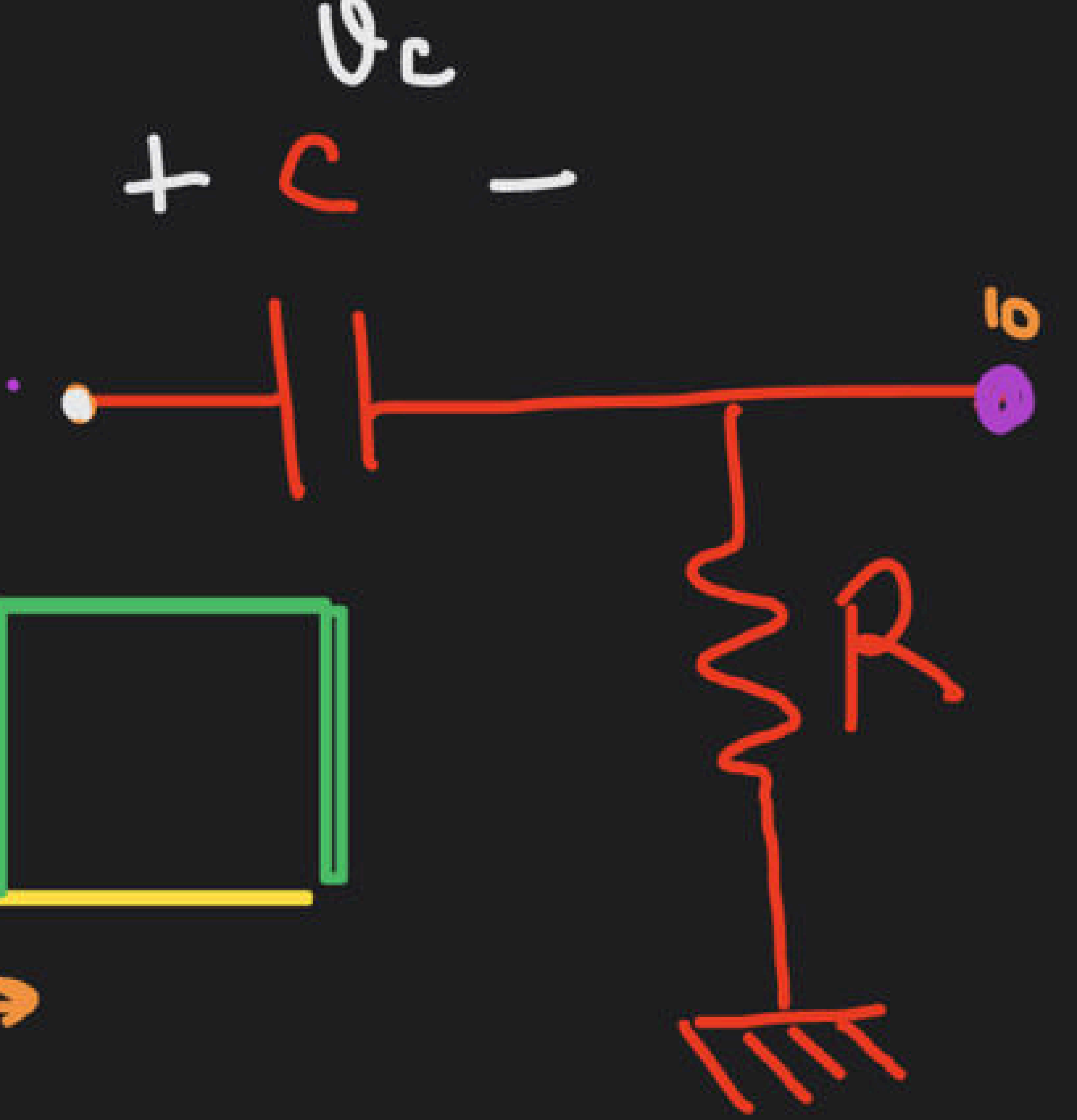
An RC-coupled amplifier is assumed to have a single-pole frequency transfer function. The maximum lower cut-off frequency allowed for the amplifier to pass 50 Hz Symmetrical. Square wave with no more than 10% tilt is ________ .

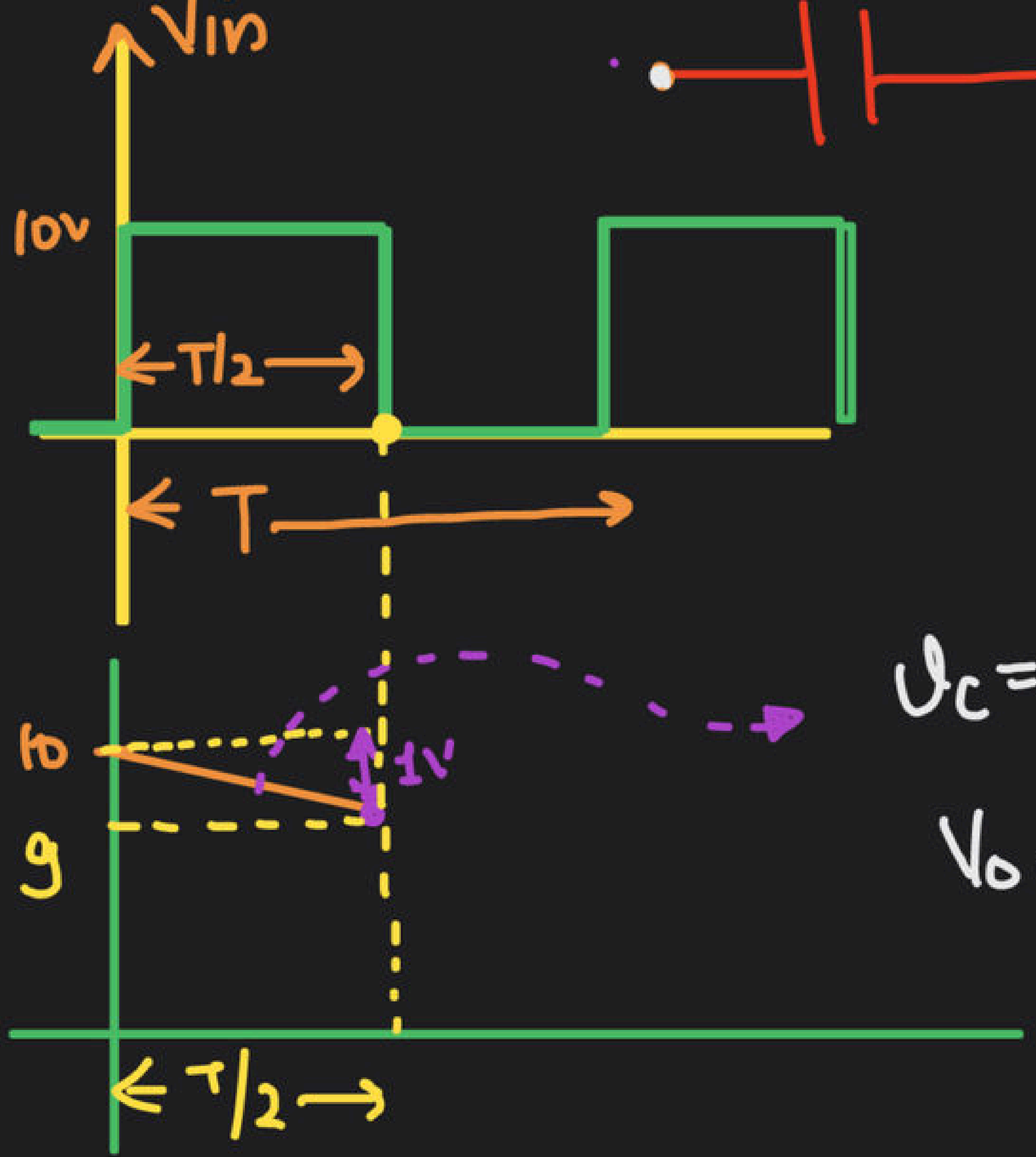
1) RC HPF



[EC-1995 : 1 Mark]

$$\omega_L = \frac{1}{RC}$$





$$v_c = 10\left(1-e^{-t/RC}\right)$$

$$V_o = 10 - v_c = \underbrace{10e^{-t/RC}} \Rightarrow$$

$$10\left[1-\frac{t}{RC}\right]$$

$$10\left[1-\frac{T/2}{RC}\right] = 9$$

$$T = 2RC\times .1$$

$$RC = \frac{T}{2\times .1} = \frac{1}{50\times 2\times .1}$$

$$RC = \frac{1}{10} = .1$$

$$\boxed{\omega_L =} \quad \frac{1}{RC} = \frac{1}{.1} = 10$$

In a multi-stage RC-coupled amplifier the coupling capacitor

(a) limits the low frequency response.

(b) limits the high frequency response.

(c) does not effect the frequency response.

(d) blocks the d.c. components without effecting the frequency response.

[EC-1993 : 1 Mark]

Q

An amplifier is assumed to have a single-pole high-frequency transfer function. The rise time of its output response to a step function input is 35 nsec. The upper –3 dB frequency (in MHz) for the amplifier to a sinusoidal input is approximately at

a) 66 b) .66 c) .066 d) 9.9

$t_r = 2.2RC$

$$RC = \frac{35}{2.2}\ ns.$$

$$\omega_H = \frac{1}{RC} = 62.8 \times 10^6\ rad/sec$$

$$f_H = \frac{\omega_H}{2\pi} = 9.9 \quad \times 10^6\ MHz$$

Q.6 The f_T of a BJT is related to its g_{m}, C_π and C_μ as follows:

Q

(a) $f_T = \dfrac{C_\pi + C_\mu}{g_m}$ (b) $f_T = \dfrac{2\pi(C_\pi + C_\mu)}{g_m}$

(c) $f_T = \dfrac{g_m}{C_\pi + C_\mu}$ (d) $f_T = \dfrac{g_m}{2\pi(C_\pi + C_\mu)}$

[EC-1998 : 1 Mark]

Q.7 An ***npn*** transistor (with $C_\pi = 0.36$ pF) has a unity gain cut-off frequency f_T of 400 MHz at a dc bias current $I_C = 1$ mA. The value of its C_μ (in pF) is approximately ($V_T = 26$ mV)

(a) 15 (b) 30

(c) 50 (d) 96

[EC-1999 : 2 Marks]

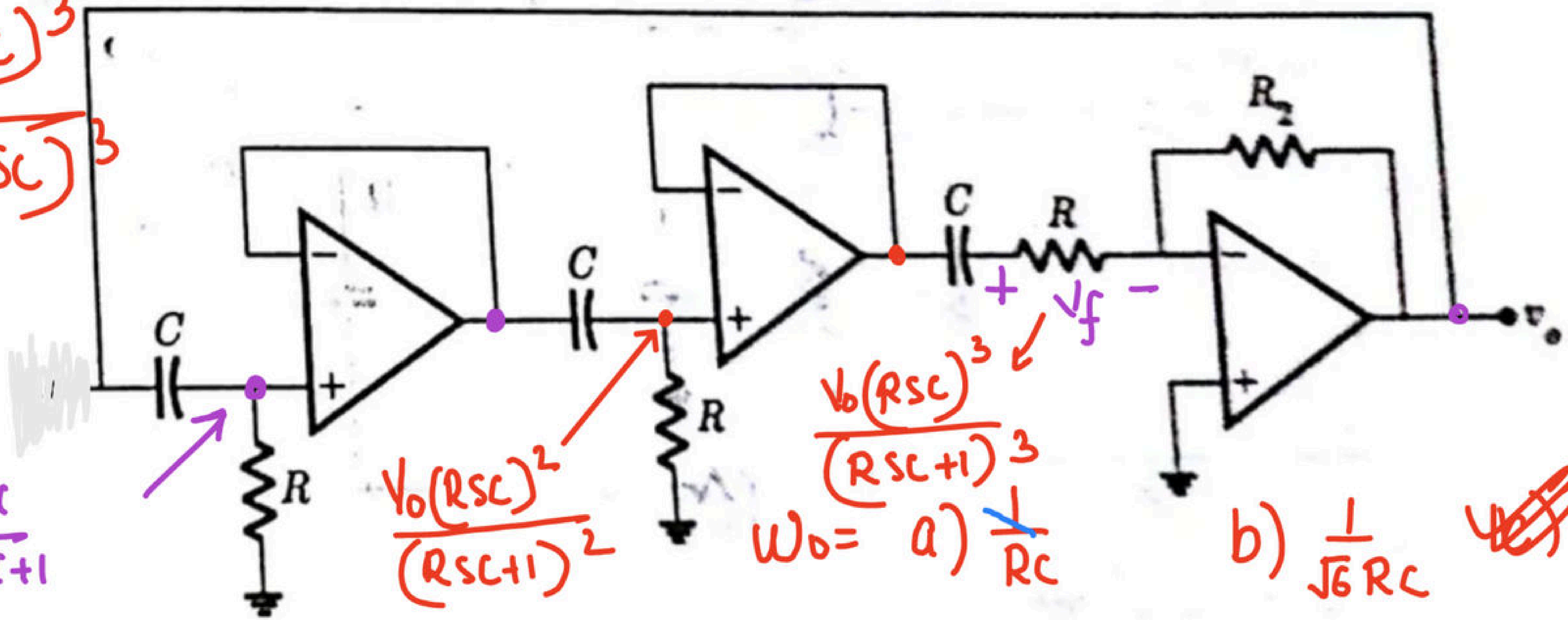
$g_m = 1/26$

$C_\mu + C_\pi = 15.30$ pF

Common Data For Q. 7 and 8 :

Consider the phase shift oscillator shown in figure with parameters $R = 4\,\text{k}\Omega$ and $C = 10\,\text{nF}$.

$V_f = V_0 \dfrac{(RSC)^3}{(1+RSC)^3}$



$V_0 \cdot \dfrac{RSC}{RSC+1}$ $\quad$ $\dfrac{V_0(RSC)^2}{(RSC+1)^2}$ $\quad$ $\dfrac{V_0(RSC)^3}{(RSC+1)^3}$ $\quad$ $+\ V_f\ -$

$\omega_0 =$ a) $\dfrac{1}{RC}$ $\quad$ b) $\dfrac{1}{\sqrt{6}RC}$ $\quad$ c) $\dfrac{1}{\sqrt{3}RC}$ $\quad$ d) $\dfrac{1}{\sqrt{6}RC}$

QUES 10.2.7 What is the frequency of oscillation (in kHz) ?

QUES 10.2.8 The required value of R_2 for the oscillation is ________ kΩ.

a) 32 b) 16 c) 4 d) 48

$$\beta = \frac{(RSC)^3}{(1+RSC)^3} =$$

$$A\beta = -\frac{R_2}{R} \cdot \frac{(RSC)^3}{\underbrace{1 + 3(RSC)^2}\, \pm 3RSC + (RSC)^3}$$

$$1$$

$$\boxed{\omega = \frac{1}{\sqrt{3}RC}}$$

$$-\frac{R_2}{R_\cdot} \cdot \frac{-j\frac{1}{3\sqrt{3}}}{j\sqrt{3} - j\frac{1}{3\sqrt{3}}} = 1$$

$$\frac{R_2}{R_1} \cdot \left(\frac{1}{9-1}\right) = 1$$

$$R_2 = \underline{\underline{32K}}$$

Revise diode

Revise EDC