1) Op-Amp Multi-Vibrator 4 pts
R1=R2=10K, C1=1uF, C2=5uF

A) Place C1 in the ckt to couple the input signal to the Op-Amp and make a mono stable out of the ckt. Show placement of the cap. 1 pt
b) On a single sheet of paper, plot from t0 to t0+2sec, Vi, Vo, node 1 and node 2. Show voltage values, times and time constants. 2 pts
c) How long is the circuit in the quasi stable state. 1 pt.

2) BJT MONOSTABLE MULTIVIBRATOR 3 pts
a) How long will the LED stay lit upon receiving a trigger pulse. Assume the trigger pulse does not effect pulse width of the one shot, it only changes state. Neglect IB3 on pulse width calculation. 2 pt
b) A one second or longer -5 volt pulse is available to trigger this one shot (shown as Vi). By adding only a capacitor, couple that pulse to the one shot so that the positive edge of the pulse will trigger the circuit. Show placement and value of cap. 1 pt.
A CMOS NOR Gate mono-stable multi-vibrator is shown: Ro=0, Ri= , VOH=5V, VOL=0V, Vth=1.5V, gate propagation delay = 0.

A Vi > Vth is recognized by the gate as an logic "1" input.
A Vi < Vth is recognized by the gate as an logic "0" input.

At t = to, S1 is initially open and circuit has reached a stable state.

Switch S1 is initially open and circuit has reached a stable state. Plot the wave forms for the following nodes showing the transition to the quasi stable state, back to the stable state and recovery:

a) VA1, 1 pt  b) Vol, 1 pt  c) VA2, 1 pt  d) Vo, 1 pt
e) Find PW 1 pt

The Op-Amp mono-stable multi-vibrator is shown with an applied input pulse of duration T1. Assume T1 is long enough for the Op-Amp to respond and execute a transition to the quasi stable state. Plot the wave forms for the following nodes showing the the transition to the quasi stable state and back to the stable state.

a) Plot the wave form at node a. 5 pts
b) Plot the wave form at node b. 5 pts
c) Plot the wave form at node c. 5 pts
d) Determine the Pulse width of the output. 10 pts

\[ V_o \text{ MAX } = 10 \text{ V} \]
\[ V_0 \text{ MIN } = -10 \text{ V} \]
BJT Monostable Multi 4 pts.
At \( t=0 \) the switch is open, then at \( t=0.1 \text{ sec} \) the switch is closed for 0.1 sec and then opened again.

a) Plot as a fcn of time: \( V_{CE1}, V_{BE2}, V_{CE2} \) for 1 sec of time.
   How voltages, times and time constants.

b) What will the LED do and for how long.
   \( V_C(\text{sat})=0.2V, V_{BE(\text{on})}=0.7V, V_F(\text{LED})=2V, \quad \beta = 100 \)

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6) OP-AMP Monostable 4 pts.

a) Place a capacitor "C2" in the circuit to make the circuit a monostable multi-vibrator.

b) What value must C2 be for a 1 sec pulse width.

c) Describe the input needed to excite this circuit into the quasi-stable state, include magnitude and polarity of that input waveform.

d) What is the maximum value that C1 can be for the input to just totally recover.

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**Vcc = 10V**

\[ V_0(\text{max}) = 10V \]
\[ V_0(\text{min}) = -10V \]
BJT Monostable Multi
At \( t=0 \) the switch is open, then at \( t=0.1 \) sec the switch is closed for 0.7 sec and then opened again.

as a fcn of time: \( VBE1, \) \( VCE1, \) \( VBE2, \) \( VCE2 \) for 3 sec of time.

5V voltages, times and times constants.

\( B=100, \; VCE(sat)=0.2V, \; VBE(on)=0.7V, \; VF(LED)=0.4V, \; 2V \)

PLOT

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BJT MONOSTABLE MULTIVIBRATOR

a) How long will the LED stay lit upon receiving a trigger pulse. 3 pts.
   Assume the trigger pulse does not effect pulse width of the one shot, it only changes state. Neglect IB3 on pulse width calculation.

b) A one second or longer -5 volt pulse is available to trigger this one shot (shown as VI). By adding only a capacitor, couple that pulse to the one shot so that the positive edge of the pulse will trigger the circuit. Show placement and value of cap. 2 pts.
V_{be(on)} = 0.7V; V_{ce(sat)} = 0; R_C1 = R_C2 = 1K; R_B1 = R_B2 = 10K; C_c = 100uF.

a) Find the steady state voltages VC_1, VC_2, VB_1, VB_2, VC_c with S_1 open. 5 pts.

b) S_1 is closed for 1 usec then opened, find the PW of the resulting output pulse. 10 pts.

c) Plot VB_2, show voltage values, PW time and time constants. 5 pts.

d) Plot V_o, show voltage values, PW time, and time constants. 5 pts.
10) **OP-AMP ASTABLE MULTI-VIBRATOR** 4 pts.
Op-Amp output values: \( V_o(\text{max}) = 10V \); \( V_o(\text{min}) = 0V \)

a) Place a 1 \( \mu F \) capacitor in the circuit to make it an Astable Multi and draw the circuit. 1 pt

b) Plot the output wave form. 1 pt.

c) Plot the wave form at the noninverting node. 1 pt.

d) Plot the wave form at the inverting node. 1 pt.

![Circuit Diagram](image)

11) **ASTABLE MULTIVIBRATOR with 555** 4 pts.

a) What is the flash rate for the LED. 1 pt

b) Plot \( V_{ca} \) vs time for 2 cycles showing times and voltage values and curve shapes. 1 pt

c) Plot \( V_o \) (on the same time scale) 1 pt.

d) Plot the output of the set compare for 2 cycles. 1 pt.

![Circuit Diagram](image)
BJT ASTABLE MULTIVIBRATOR
Plot node B and node C of Q1 for two cycles showing all voltages, times and time constants.

\[ B = 200 \]
\[ V_{BE(on)} = 0.7V \]
3) SCHMITT TRIGGER EMPLOYING COMPARATOR 3 PTS
   a) Determine VILTP and VIUTP 1 pt
   b) Determine VOH 1 pt
   c) Plot the transfer curve of Vo vs Vi. 1 pt
      RL=2K; R1=3K; R2=5K
      Comparator output values: Vo'(high)= High Z; Vo'(low)= GROUND

4) OP-AMP ASTABLE MULTI-VIBRATOR 4 PTS
   Op-Amp output values: Vo(max)=10V; Vo(min)=-10V
   R=100K; R1=100K; R2=100K
   a) Place a capacitor in the circuit to make it an Astable Multi. 1 pt
   b) Plot the wave form at the node. 1 pt.
   c) Plot the wave form at the node. 1 pt.
   d) Determine the value of the cap for frequency of oscillation = 300 Hz. 1 pt