d) FREE RUNNING WAVEFORM GENERATOR 5 pts
VCC=10V, VEE=-10V, VSO(max)=10V, VSO(min)=-10V, Ro (Op Amp)=0, VD(on)=0V, B(Q1)=100, VBE(on)=0.7V

a) Find UTP and LTP of Schmitt Trigger ckt. 1 pt.
b) Find discharge rate of C1 when VSO=10V. 1 pt.
c) Plot Vo vs time for two cycles show voltage levels. 1 pt.
d) Find time to ramp up and ramp down. 1 pt.
e) Find max linearity error for positive ramp. 1 pt.
2) OP-AMP RAMP GENERATOR 5 pts
R1=10K; RB=10K; C1=7000pF; C2=0.01uF; C3=0.5uF; Vf(D1)=0.7V; Ir(D1)=0;
Initially S1 is OPENED, at t=t1 switch S1 is CLOSED as remains CLOSED forever.

a) Plot the voltage at the base of Q1 for 100 uS past t1, showing voltage levels, times and time constants. 1 pt.
b) Plot Vo for 100 uS past t1. [Apply parts (c) and (d) to the plot when you finish those parts] 1 pt

c) Determine the ramp rate of the output voltage and the peak ramping voltage. 1 pt.
d) Determine the "return to zero" time of the output voltage when Q1 is on. 1 pt.
e) What is the exact value of node K at the end of the positive ramping when considering the tilt of C3. 1pt
**3.** UJT Pulse Train Generator 4 pts

UJT: $I_{E(on)} = 10 \, mA; \, V_{EB(sat)} = 1V; \, V_{peak} = \eta V_{BB} + 0.7V; \, \eta = 0.53$

Op Amp: $V_{o(max)} = V_CC; \, V_{o(min)} = V_EE.$

a) Plot node 1 vs time for two cycles. 1 pt.
b) Determine $V_{ILTP} \& V_{IUTP}$ of the Schmitt Trigger. 1 pt.
c) Plot the output voltage. 1 pt.
d) Determine the Pulse width and Space of the output. 1 pt.

![UJT Circuit Diagram]

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**8.4.** FUNCTION GENERATOR 4 pts.

Assume: $V_{o(max)} = V_{cc} - 1V; \, V_{o(min)} = -V_{ee} + 1V;$

a) Find UTP and LTP of Schmitt Trigger. 1 pt.
b) Find $\Delta V_{o}/\Delta t$ of miller integrator. 1 pt.
c) Plot 2 cycles of $V_{o1}; \, V_{o2}$ vs time 2 pts.

Use 1 page for plots and align times axis, show all voltage levels and time points.

![Function Generator Circuit Diagram]
5) UJT RELAXATION OSCILLATOR 4 pts.
A constant current source supplies the current for charging C1 in a
free running linear generator. The parameters for the UJT are:
n = 0.63, \text{Ie(on)} = 11 \text{ mA}, \text{Veb (sat)} = 2 \text{ volts}, \text{Vp} = nVbb + 0.7V.

a) Find \( \Delta V_o/\Delta t \) when Q2 is off. 1 pt
b) Find \( \Delta V_o/\Delta t \) when Q2 is on. 1 pt
c) Plot VC1 for 2 cycles showing times and voltages. 1 pt.
d) Plot the output of the pulse width modulator Vo. 1pt.

6) Boot Strap Ramp Generator 4 pts.

\[ V_{BE(on)} = 0.7V; \ V_{D(on)} = 0.7V; \ V_{CC} = 10V; \ V_{EE} = -10V; \ V_{z} = 5V; \ B = 50. \]
a) What is the ramp rate after S1 is opened. 1 pt.
b) Plot Vo vs Time, for one second after S1 is opened. Show voltage levels and times. 1 pt.
c) Calculate the change in VC3 during ramping.
d) What is non linear error due to change in Base currents.