K. J. SOMAIYA COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRONICS ENGINEERING
ELECTRONIC CIRCUITS
Oscillator Circuits

Q1. Design a RC Phase shift oscillator to oscillator at 900Hz supply voltage is 10V:

Solution:

1) Select transistor BC 147A:
$h_{fe(type)} = 220 = 20$V, r_π 2.7kΩ, $V_{CE(sat)} = 0.25V$, $\beta = 180$

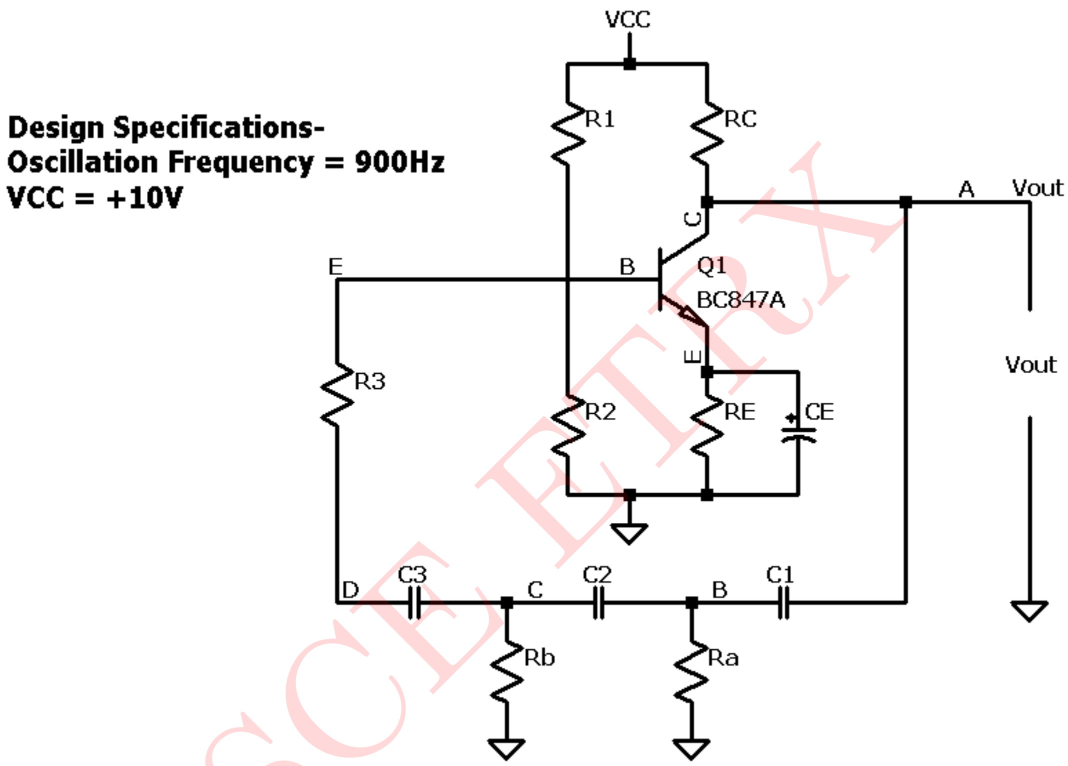

Figure 1: Self baised Circuit 1

2) Selection of R and C:

For RC shift oscillator

$f = \dfrac{1}{2\pi RC} \times \dfrac{1}{\sqrt{6+4k}}$

Minimum value of k is 2.7

$900 = \dfrac{1}{2\pi RC} \times \dfrac{1}{\sqrt{6+4k}}$

RC = 43.1451μA

let C = 0.01μF

$R = \dfrac{43.1451 \times 10^{-6}}{0.01 \times 10^{-6}} = 4.314\text{k}\Omega$

Select $R = 4.7k\Omega$, 1/4 W (H.S.V)

3) Selection of R_C:

$k = \dfrac{R_C}{R}$ $R_C = 2.7 \times 4.7k = 12.690\text{k}\Omega$

Select $R_C = 15k\Omega$, 1/4 W (H.S.V)

4) Selection of R_E:

$V_{RE} = 0.1V_{CC} = 10 \times 0.1$

$V_{RE} = 1\text{V}$ (For good stability)

For maximum symmetrical o/p voltage swing, select Q point at centre of DC load line

$V_{CEQ} = 5\text{V}$

$I_{CQ} = \dfrac{V_{CC} - V_{CE} - V_{RE}}{R_C} = \dfrac{10-6}{15k}$

$I_{CQ} = 0.2667\text{mA}$

$I_{CQ} = \alpha I_{EQ}$

$\alpha = \dfrac{\beta}{1+\beta} = \dfrac{180}{181} = 0.994$

$I_{EQ} = I_{CQ}/\alpha = 0,2667mA/0.994 = 0.2683\text{mA}$

$V_{RE} = I_{EQ}R_E$

$R_E = \dfrac{V_{RE}}{I_{EQ}} = 1/0.26683mA = 3.72\text{k}$

Select $R_E = 3.3\Omega$, 1/4 W (H.S.V)

5) Selection of R_1 and R_2:

$$S = \frac{1+\beta}{1+\beta\left(\dfrac{R_E}{R_E+R_B}\right)}$$

$$8 = \frac{1+180}{1+180\left(\dfrac{3.3k}{3.3k+R_B}\right)}$$

$R_B = 24.177\text{k}\Omega$ ——— (1)

KVL at B-E loop

$V_B - I_{BQ}R_B - V_{BE} - I_{EQ}R_E = 0$

$V_B = I_{CQ}R_B/\beta + V_{BE} + I_{CQ}R_E$

$V_B = 124.177k \times 2.667m/180 + 0.7 + (0.2683m \times 3.3k$

$V_B = 1.6212$ Now from (2)

$1.6212 = \dfrac{R_2}{R_1+R_2}V_{CC}$ ——— (2)

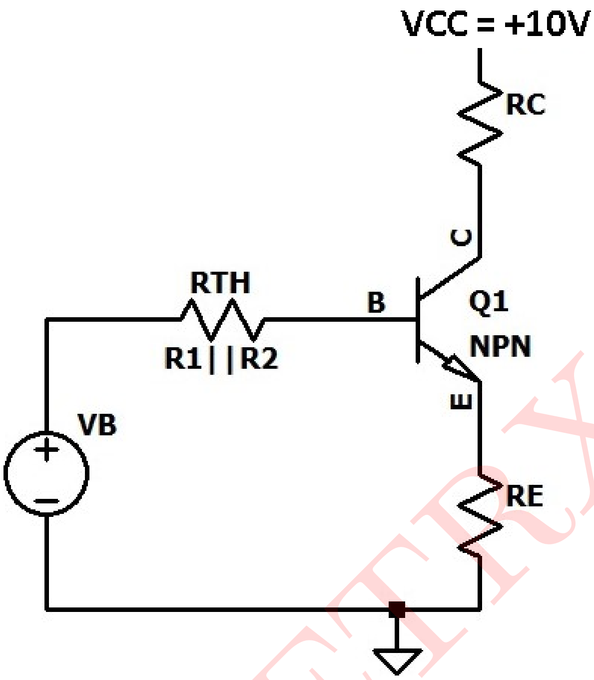

Figure 2: DC equivalent circuit

$\frac{R_2}{R_1 + R_2} = 1.6212$ ——— (3)

Solving equations (3) and (1)

$R_1(1.6212) = 24.177k$

$R_1 = 149.86k\Omega$

Select $R_1 = 150k\Omega$, 1/4 W (H.S.V)

From (3)

$\frac{R_2}{150k + R_2} = 1.6212$

$R_2 = 29.023k\Omega$

Select $R_2 = 27k\Omega$, 1/4 W (H.S.V)

6) Selection of C_E:

$X_{CE} \leq 0.1R_E$

$C_E = \frac{1}{2\pi \times f_{LCS} 0.1R_E}$

$C_E = \frac{1}{2\pi \times 0.1 \times 900 \times 3.3k} = 0.5358\mu F$

Select $C_E = 1\mu$F, 50V (H.S.V)

7) Selection of R_3 in R_C selection:

To avoid loading effect of input impedence of BJT towards third (R_3) in RC section

$R_i = R_1||R_2||R_\pi = 2.415\text{k}\Omega$

$R_3 = R + R_i = 4.7k + 2.415k = 7.115\text{k}\Omega$

Select $R_3 = 7.115k\Omega$, 1/4 W (H.S.V)

8) Designed Circuit is:

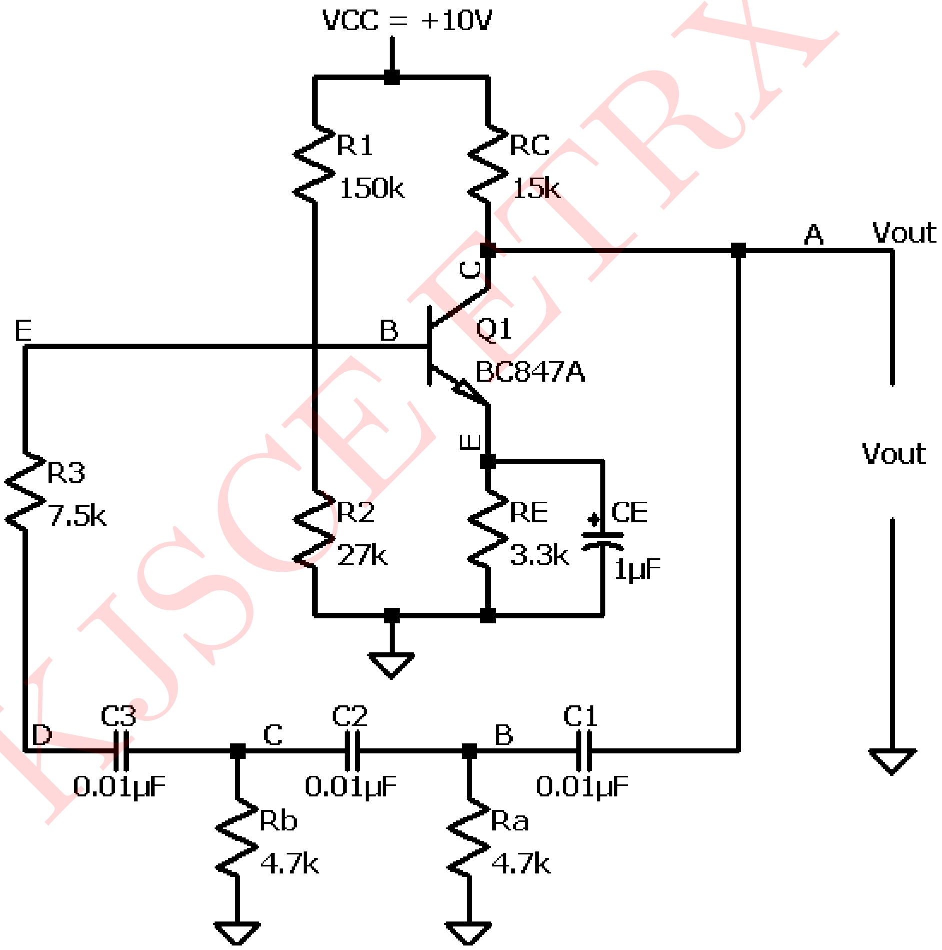

Figure 3: Designed circuit 1

SIMULATED RESULTS:

Above circuit is simulated in LTspice and results are as follows

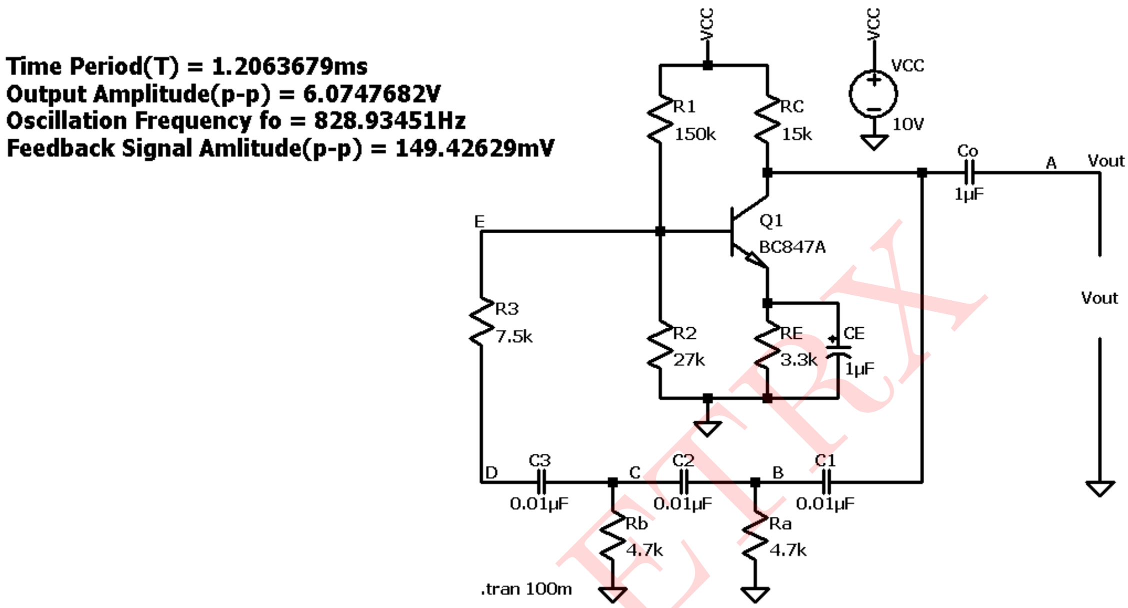

Figure 4: Circuit schematic 1

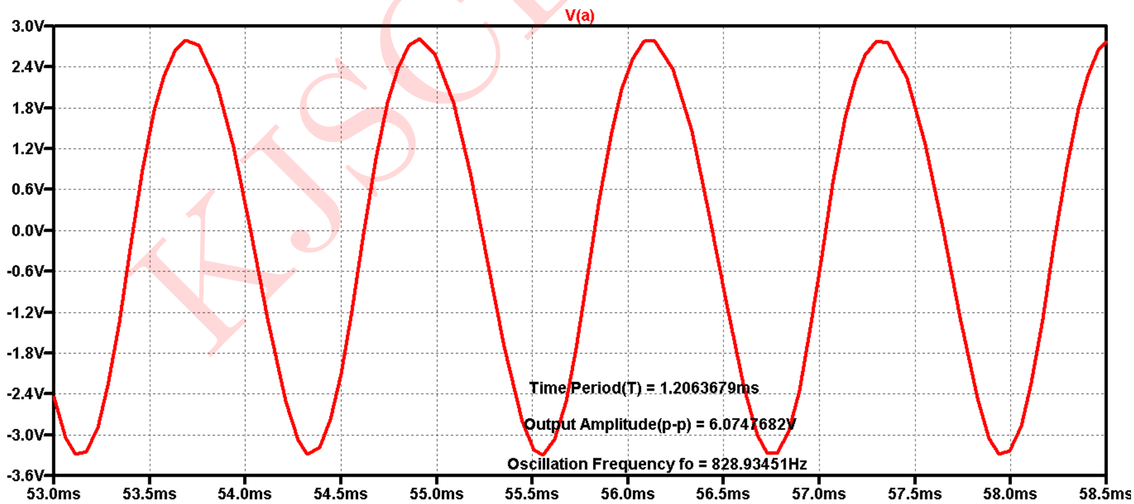

Figure 5: Expanded view of output waveforms

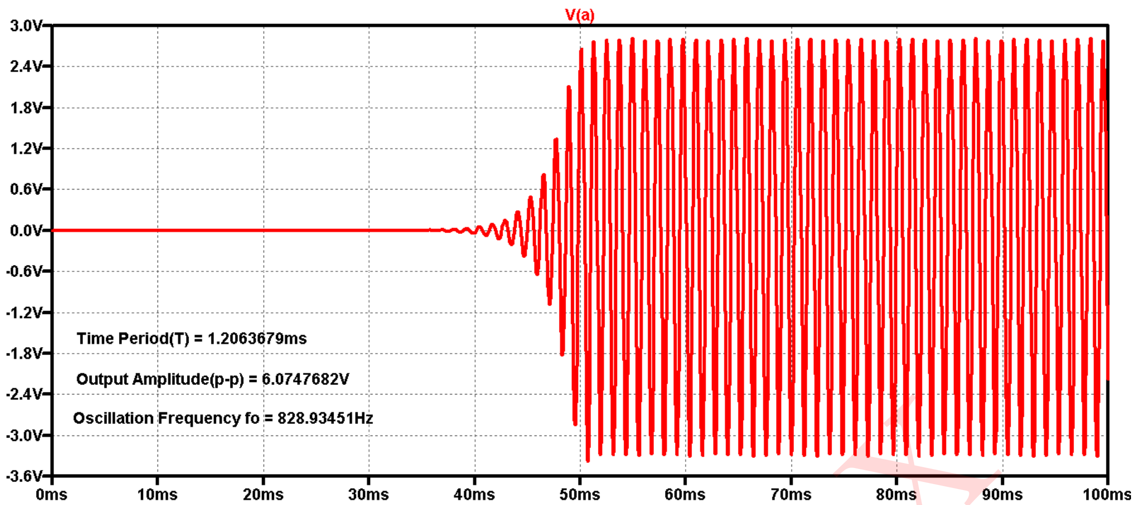

Figure 6: Output voltage Waveform

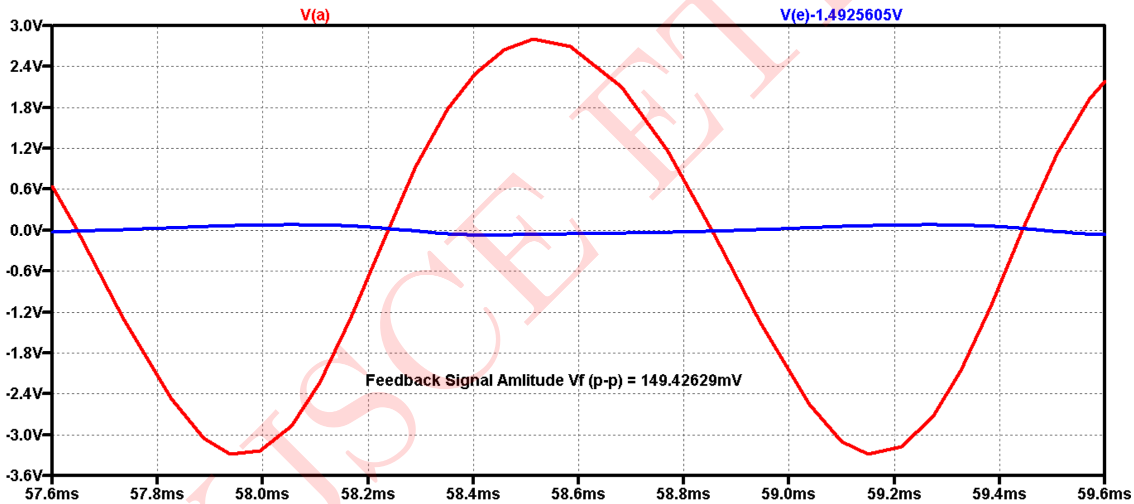

Figure 7: Output and feedback voltage Waveform

Comparsion between Simulated and theoretical values :

Parameters	Simulated	Theoretical
Frequency of oscillation	828.93451Hz	900Hz
Times period	1.206367ms	1.1111ms
Amplitude of output	6.074768V	–
Peak to Peak feedback signal	149.4263mA	–
Feedback fraction	0.024	0.0344
Phase shift offered by feedback network	180°	180°

Table 1: Numerical 1