IEC 103

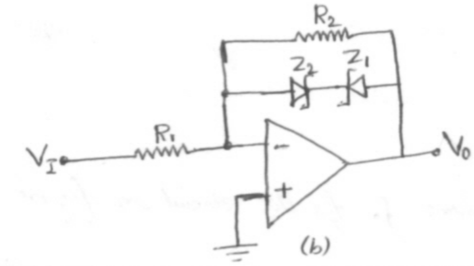
Assignment-6
Oscillators

1. Consider a sinusoidal oscillator consisting of an amplifier having a frequency independent gain A (where A is positive) and a second order bandpass filter with a pole frequency ω_0 and a centre frequency gain K.
   (a) Find the frequency of oscillation and the condition that A and K must satisfy for sustained oscillation.
   (b) Derive an expression for $\frac{d\phi}{d\omega}$, evaluated at $\omega = \omega_0$.
   (c) Use the result of (b) to find an expression for the per unit change in frequency of oscillation resulting from a phase angle change of $\Delta\phi$ in the amplifier transfer function.

2. An oscillator is formed by loading a transconductance amplifier having a positive gain with a parallel RLC circuit and connecting the output directly to the input (thus applying positive feedback with $\beta = 1$). Let the transconductance amplifier have an input resistance of $10K\Omega$ and an output resistance of $10K\Omega$. The LC resonator has $L = 10\mu H$, $C = 1000pF$ and $Q = 100$. For what value of transconductance G_m will the circuit oscillate?

3. In an oscillator circuit, the frequency selective network exhibits a loss of 20 dB and a phase shift of 180° at ω_0. What is the minimum gain and phase shift that the amplifier must have for oscillation to begin?

4. Consider the circuit in figure 1.



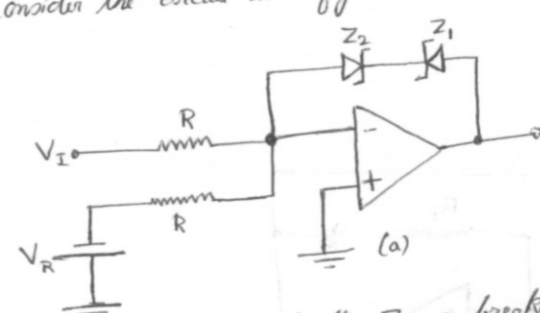


Figure 1

Let V_{Z1} and V_{Z2} be the Zener breakdown voltages of Zener diodes Z_1 and Z_2 respectively. Assume the diodes have a forward drop of 0.7V. Sketch and label the transfer characteristics of circuits in figure 1.

5. Consider an usual Wien bridge oscillator circuit. Show that its frequency selective feedback network is actually a bandpass filter. Find its frequency of oscillation and centre frequency gain.

6. Consider the circuit in figure 2. Find L(s), L(jω), frequency for zero loop phase, and R_2/R_1 for oscillation.

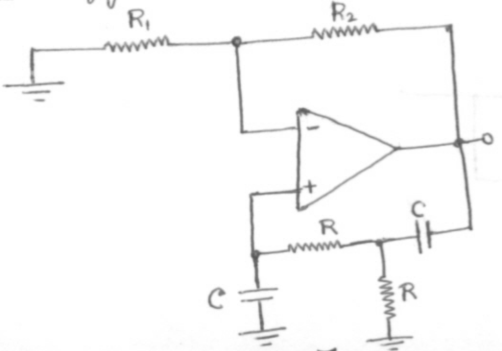


Figure 2

7. Calculate $L(s)$, $L(j\omega)$, frequency for zero loop-phase and R_2/R_1 for oscillation for the circuit in figure 3.

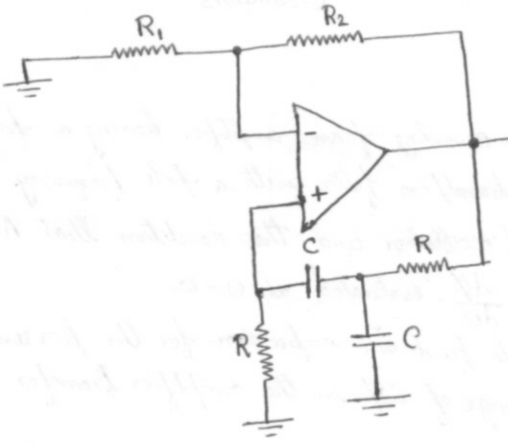


Figure 3

8. Consider the circuit in figure 4. Find V_x in terms of V_o. For $R = 10K\Omega$, find C and R_f to obtain sinusoidal oscillations at 10KHz.

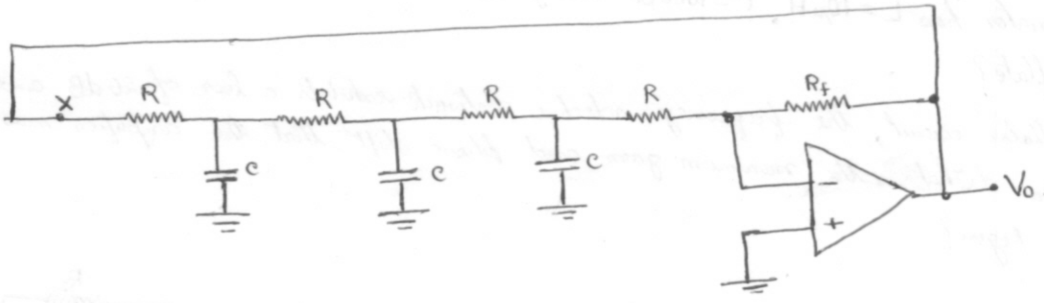


Figure 4

9. Determine f_o for the circuit in figure 5.

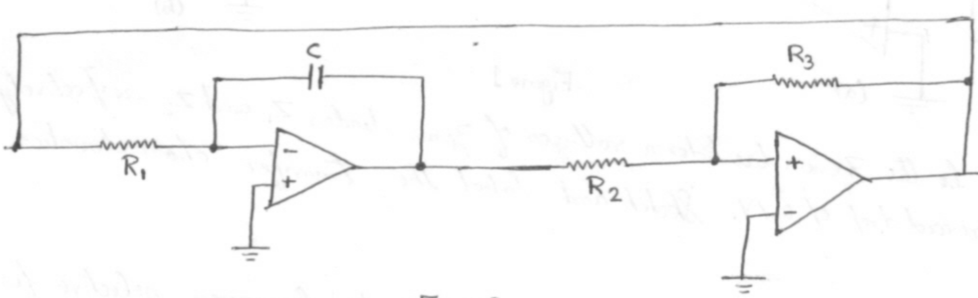


Figure 5.

10. Repeat problem 9 if $R_1 = R_2$.

11. Determine the frequency of oscillation of the circuit in figure 6.

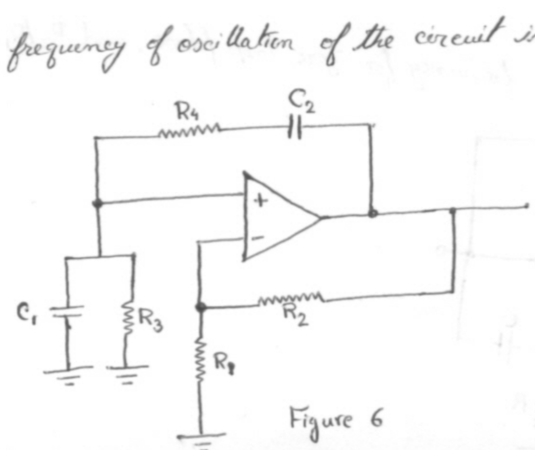


Figure 6

12. Design a phase shift oscillator so that $f_o = 1KHz$.

13. Design a Wien bridge oscillator that will oscillate at 2 KHz.

14. Design a quadrature oscillator to operate at a frequency of 1·5 KHz.

15. Derive an expression for the frequency of oscillation of the circuit shown in figure 7. What is the ratio R_2/R_1 required for oscillation?

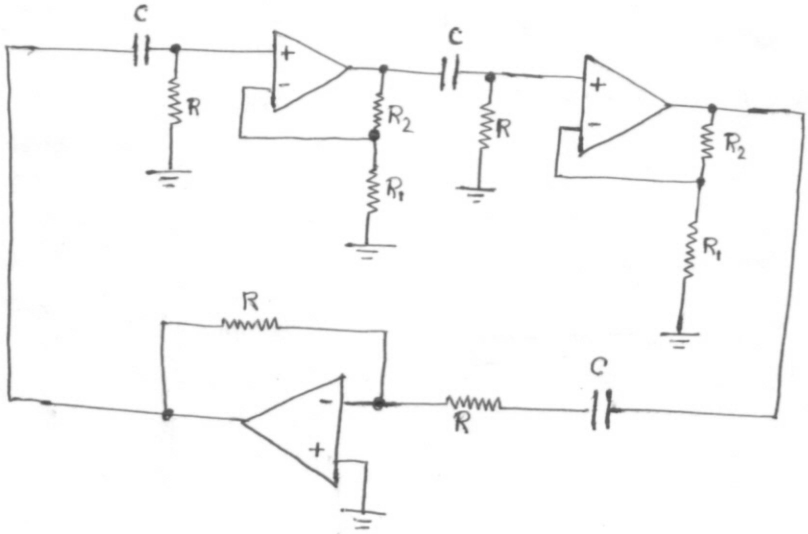


Figure 7

16. A crystal has a series resonant frequency of 10MHz, series resistance of 40Ω, Q factor of 25000, and parallel capacitance of 10 pF. (a) What are the values of L and C_s for this crystal? (b) What is the parallel resonant frequency of the crystal? (c) The crystal is placed in an oscillator circuit in parallel with a total capacitance of 22pF. What will be the frequency of oscillation.