IEC 103

Assignment-8

Monostable Multivibrator

Integrated Circuit Timer

Analog Computer.

1. Consider a 555 timer circuit. Suppose the threshold and trigger input terminals are joined together and connected to an input voltage V_I. Verify that the transfer characteristic $V_o - V_I$ is that of an inverting bistable circuit with thresholds $V_{TL} = \frac{1}{3}V_{cc}$ and $V_{TH} = \frac{2}{3}V_{cc}$ and output levels of 0 and V_{cc}.

2. Consider a monostable multivibrator circuit. In the stable state, $V_o = L_+$, $V_A = 0$ and $V_B = -V_{ref}$. The circuit can be triggered by applying a positive input pulse of height greater than V_{ref}. For normal operation of the circuit in figure 1, $C_1R_1 << CR$. Find out the resulting waveforms of V_o and V_A. Also show that the pulse generated at the output will have a width T given by $T = CR \ln\left(\frac{L_+ - L_-}{V_{ref}}\right)$. Show that the pulse width can be controlled by changing V_{ref}.

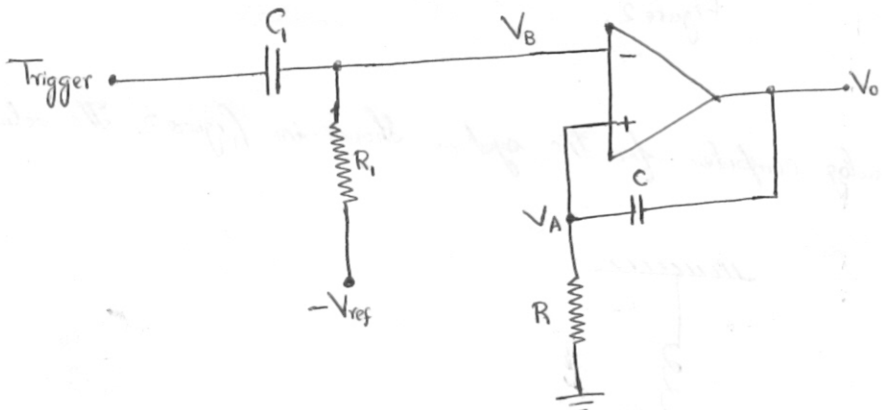

Figure 1

3. Consider the basic design of a monostable multivibrator circuit. The op-amp that has been used has saturation levels ±13V, design a monostable multivibrator to provide a negative output pulse of 100μs duration. Use capacitors of 0.1nF and 1nF. Wherever possible, choose resistors of 100KΩ in your design. Diodes have a drop of 0.7V. What is the minimum input step size that will ensure triggering? How long does the circuit take to recover to a state in which retriggering is possible with a normal output?

4. Consider a monostable multivibrator circuit implemented using a 555 timer circuit. Using a 1nF capacitor C, find the value of R that results in an output pulse of 10μs duration. If the 555 timer is powered with $V_{cc} = 15V$ and assuming that V_{TH} can be varied externally, find its required value so that the pulse width is increased to 20μs.

5. The node in the 555 timer, at which the voltage is V_{TH} is usually connected to an external terminal. This allows the user to change V_{TH} externally. Show that whatever the value of V_{TH} becomes, V_{TL} always remains $\frac{1}{2}V_{TH}$. Consider an astable multivibrator circuit implemented using 555 timer. Find out the expressions for T_H and T_L in terms of V_{TH} and V_{TL}. For the case $C = 1nF$, $R_A = 7.2K\Omega$, $R_B = 3.6K\Omega$ and $V_{cc} = 5V$ find the frequency of oscillation f and duty cycle of resulting square wave when no

external voltage is applied to terminal V_{TH}. Consider a sine wave of frequency much lower than that of f and of 1-V peak amplitude that is capacitively coupled to the circuit node V_{TH}. This signal will cause V_{TH} to change around its quiescent value of $\frac{2}{3}V_{cc}$, and T_H will change correspondingly — a modulation process. Find T_H, and find the frequency of oscillation and the duty cycle at the two extreme values of V_{TH}.

6. Design an analog computer for the spring mass system as shown in figure 2. F is the force being applied, K is the spring constant and D is the damping constant of the surface.

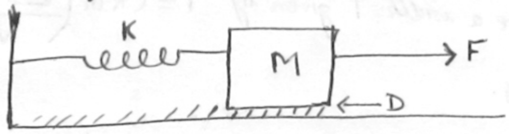

Figure 2.

7. Design an electrical analog computer for the system shown in figure 3. The volume of mass M is V.

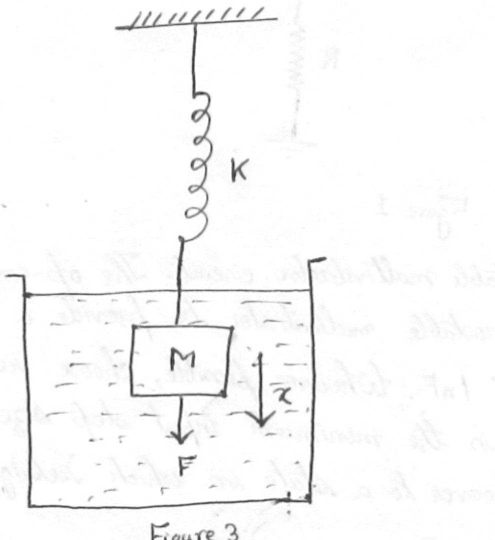

Figure 3

8. Repeat problems 6 and 7 by designing passive circuits to simulate the system.

9. Draw an electrical analog for the mechanical system shown in figure 4.

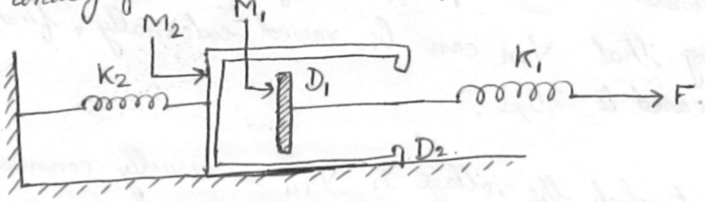

Figure 4.

10. Repeat problem no. 9 using an analog computer based on op-amp.