EXPERIMENT – 4

AIM: LTI system response.

OBJECTIVE:

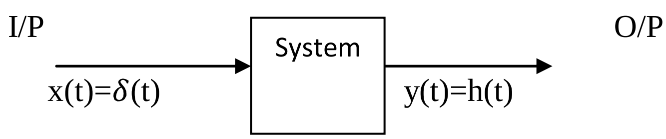
i. Finding out system response for
   a. impulse input
   b. step input
   c. Arbitrary input.

ii. Finding out response of a Frequency Modulator.

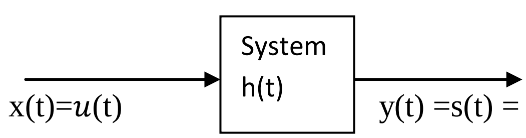
SOFTWARE REQUIRED: MATLAB

Pre-Lab

Impulse Response:-When the input signal to a LTI-system is unit impulse $\delta(t)$ then the output of the system is called as Impulse Response. $h(t)$ of the system



Step Response:-Step input signal are often used to characterize the response of an LTI system to sudden changes in the input. Hence it is defined as “Output of the LTI system” when the input is a unit step signal.



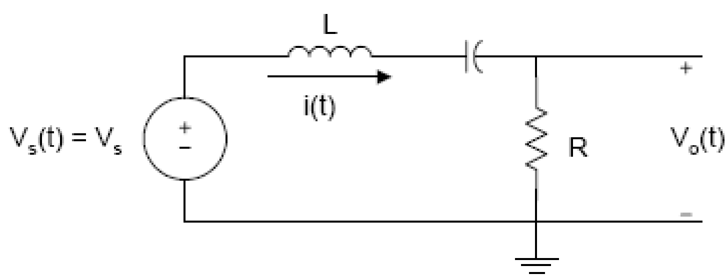
y(t) =s(t) = x(t)*h(t) = h(t)*x(t) .

Hence the step response of the LTI system is calculated as convolution of the unit step with impulse response of the LTI system.

$$y(t) = s(t) = \int_{-\infty}^{\infty} h(\tau)u(t-\tau)d\tau$$

*Step response '$S(t)$' of a continuous time LTI system is running integral of the impulse response $h(t)$.

Following circuit is a series RLC Circuit which can be analyzed like an LTI system



$$v_s(t) = L\frac{di(t)}{dt} + \frac{1}{c}\int_{-\infty}^{t} i(\tau)d\tau + Ri(t)$$

Differentiating the above expression we get:

$$\frac{dv_s(t)}{dt} = L\frac{d^2i(t)}{dt^2} + R\frac{di(t)}{dt} + \frac{i(t)}{c} \quad \text{i.e}$$

$$\frac{1}{L}\frac{dv_s(t)}{dt} = \frac{d^2i(t)}{dt^2} + \frac{R}{L}\frac{di(t)}{dt} + \frac{i(t)}{Lc}$$

In-Lab

1. Find the response y(t) of a system with impulse response $h(t) = u(t) - u(t-1)$ to an input $x(t) = u(t) - u(t-1)$. Use convolution integral. Plot $x(t), h(t), and\ y(t)$.

2. For the above series RLC circuit find out i(t) if the initial conditions given are L=10 H , R=400 ohms and C=100μF with i(0)=4 Amp and i'(0)= 15 amp/s.
   (a) v_s (t) = $\delta(t)$
   (b) v_s (t) =u(t).

Post- Lab

Frequency modulation or FM uses a wider bandwidth than amplitude modulation or AM but it is not affected as much as by noise as AM is. The output of an FM transmitter is of the form

$$y(t) = \cos(\Omega_c t + 2\pi\nu \int_0^t m(\tau)d\tau$$

Where m(t) is the message and frequency ν is in Hz/volt and the units of message are in volts.

(a) Create as the message a signal m(t)=cos (t). find the FM signal y(t) with ν=10 and then for ν=1. Let the carrier frequency $\Omega_c = 2\pi$. Use MATLAB to generate different signals for times 0≤t≤10 at intervals Ts =0.01. Plot m(t) and the 2 FM signals for ν=10 and ν=1 in the same plot. Is the FM transmitter a linear system? Explain.

(b) Create a message signal

$$m_1(t) = \begin{cases} 1 \text{ } when \text{ } m(t) \geq 0 \\ -1 \text{ } when \text{ } m(t) < 0 \end{cases}$$

Find the corresponding FM signal for ν=1