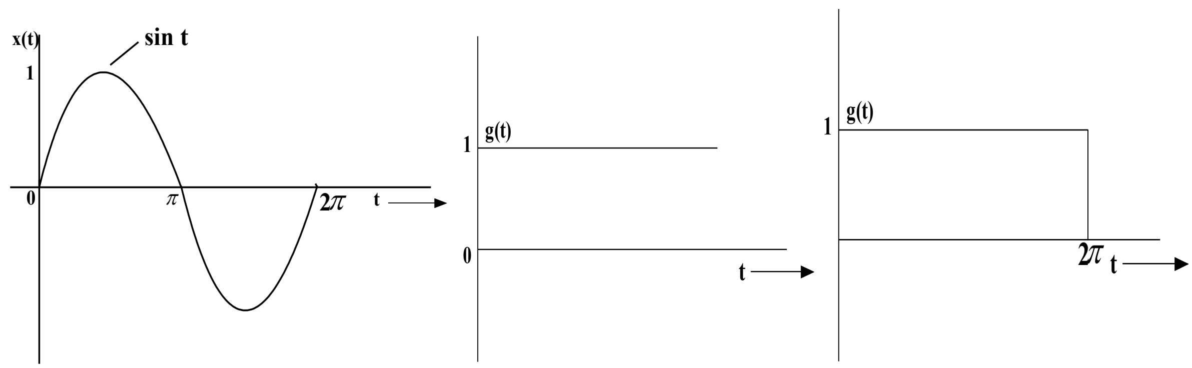
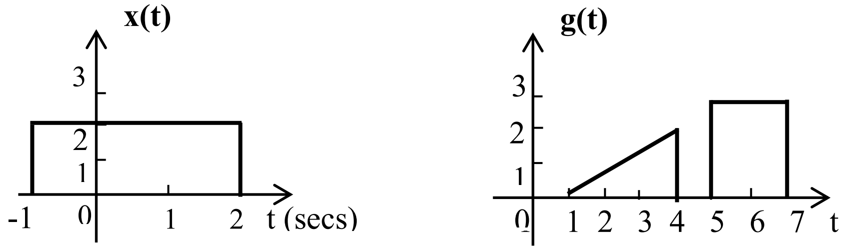
Week-6 (Time Domain Analysis) –Excercises

1. Sketch the functions $x(t) = \frac{1}{t^2+1}$ and u(t). Now find *x(t)* * *u(t)* for various time range and sketch the result. Select the appropriate presentation ranges while using the convolution.
2. Figure below shows x(t) and g(t). Find manually the expression for c(t) = x(t) * g(t) and sketch the same. What are the changes in c(t), **i)** if the signal x(t) is everlasting, **ii)** if the signal x(t) is everlasting and if the frequency of the signal x(t) is changed. Comment on the output signal duration and pattern of variation of c(t).



3) Find manually the expression for c(t) = x(t) * g(t) and sketch the same, given the following signals.



4) The periodic signal x(t) shown in the following Fig.1, is input to a system having impulse response, h(t) = t (u(t)–u(t–1.5)). Use convolution to determine the output y(t) for this system. Sketch y(t) over ($-3 \le t \le 3$) s. If x(t) variation is t instead of t^2, observe how the output varies? **Tabulate for all continuous time ranges**, clearly the "**integrating time ranges"** (upper and lower limits) & "**function to be integrated**" respectively, so that the mathematical expression to y(t) = x(t)*h(t) (consider x(τ) and h(t- τ)) can be found out. Find the mathematical expression for y(t), at least two ranges and verify the result using MATLAB.

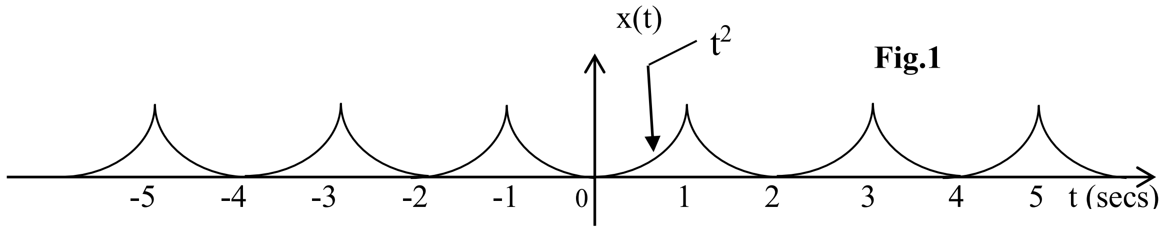


Fig.1

Sample table for filling the values

Continuous time range	Integrating time range	Function to be integrated

5) Classify with reasons, given the LTIC system described by the following equations are

i) externally stable or unstable (in the BIBO sense)
ii) internally asymptotically stable, unstable, or marginally stable.

a) $(D^2+8D+12)\ y(t) = (D-1)\ x(t)$
b) $D(D^2+3D+2)y(t) = (D+5)x(t)$
c) $D^2\ (D^2+2)y(t) = x(t)$
d) $(D+1)(D^2-6D+5)y(t) = (3D+1)x(t)$
e) $(D+1)\ (D^2+2D+5)^2\ y(t) = x(t)$
f) $(D+1)(D^2+9)y(t) = (2D+9)x(t)$
g) $(D+1)(D^2+9)^2\ y(t) = (2D+9)x(t)$
h) $(D^2+1)(D^2+4)(D^2+9)y(t) = (3D)x(t)$

Plot the **typical forced** response, **ZSR** (assuming suitable forcing function) and **free (natural)** responses in each case, and identify/observe and comment on the intuitive insights into system behaviors and/or verify it by solving the equations.