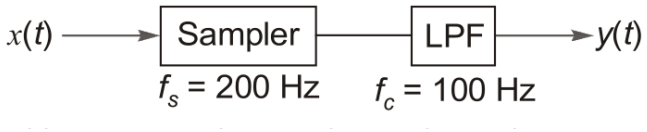
GATE:EE/63

EE23BTECH11208 - Manohar K*

Question: A signal $x(t) = 2\cos(180\pi t)\cos(60\pi t)$ is sampled at 200 Hz and then passed through an ideal low pass filter having cut-off frequency of 100 Hz.
The maximum Frequency present in the filtered signal in Hz is ____ (Round off to the nearest integer.) (GATE 2023 EE)

Solution:
Given,



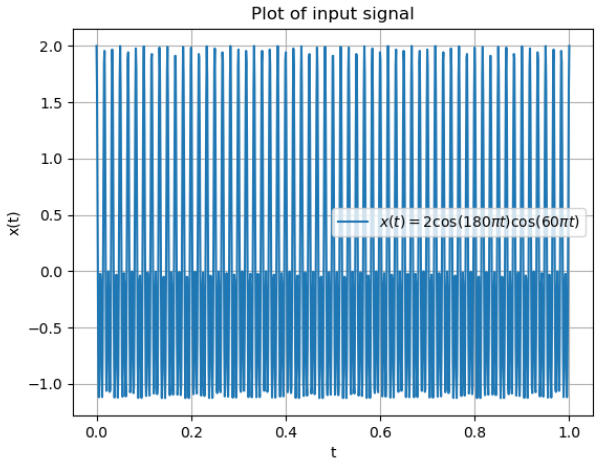


Fig. 1. Plot of x(t) vs t

symbol	value	description
$x(t)$	$2\cos(180\pi t)\cos(60\pi t)$	input signal
f_s	$200Hz$	sampling frequency
f_c	$100Hz$	cut-off frequency of low pass filter
$y(t)$		output signal

TABLE I
PARAMETERS

$$x(t) = cos(240\pi t) + cos(120\pi t) \quad (1)$$

Here, the input signal can be assumed as sum of two individual signals with frequency $f_1 = 120Hz$ and $f_2 = 60Hz$.
The frequency components present at sampler output :

$$\implies f_1, (f_s \pm f_1), (2f_s \pm f_1)\ldots \quad (2)$$
$$\implies f_2, (f_s \pm f_2), (2f_s \pm f_2)\ldots \quad (3)$$
$$eq(2) \implies 120, 80, 340, 280, 520\ldots \quad (4)$$
$$eq(3) \implies 60, 140, 260, 34, 460\ldots \quad (5)$$

From table $f_c = 100Hz$
LPF output : $60Hz$, $80Hz$
Maximum Frequency present in the filtered signal is $80Hz$

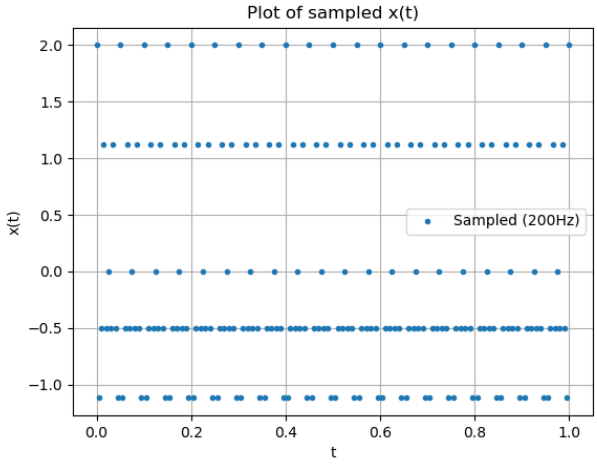


Fig. 2. Plot of x(t) vs t