IIR Filter #6

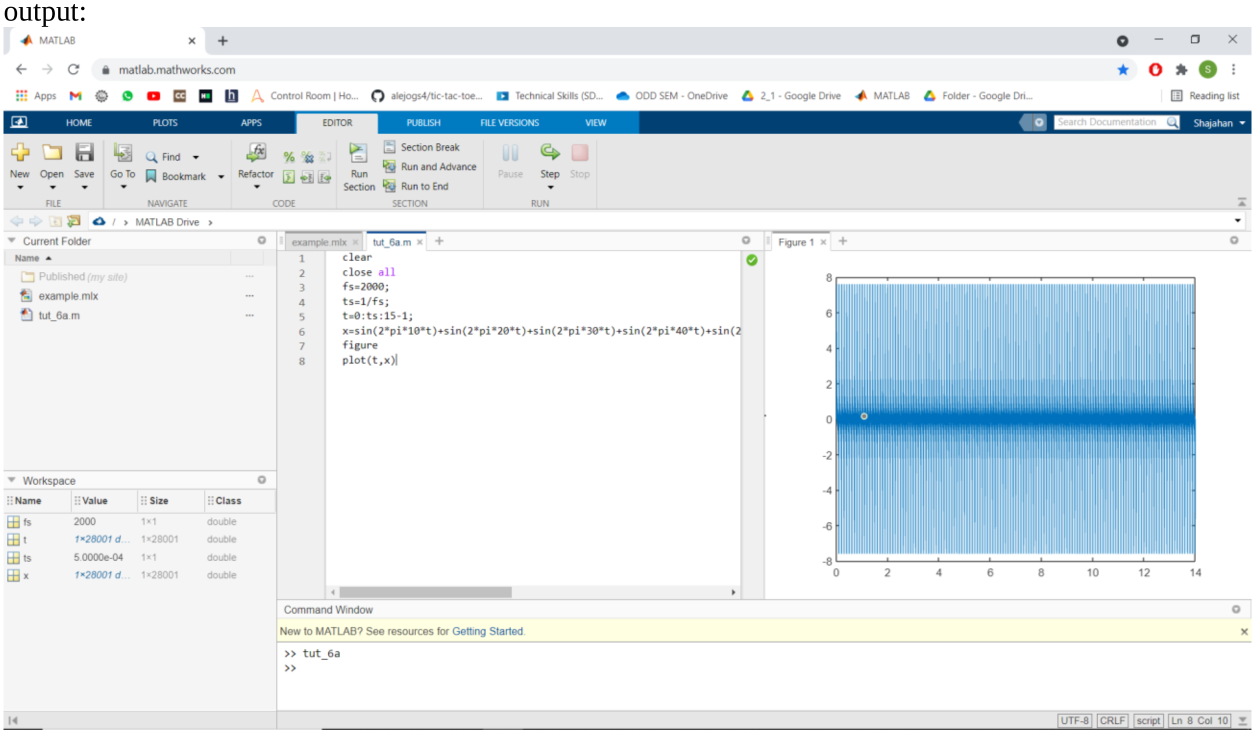
IN-TUTORIAL:

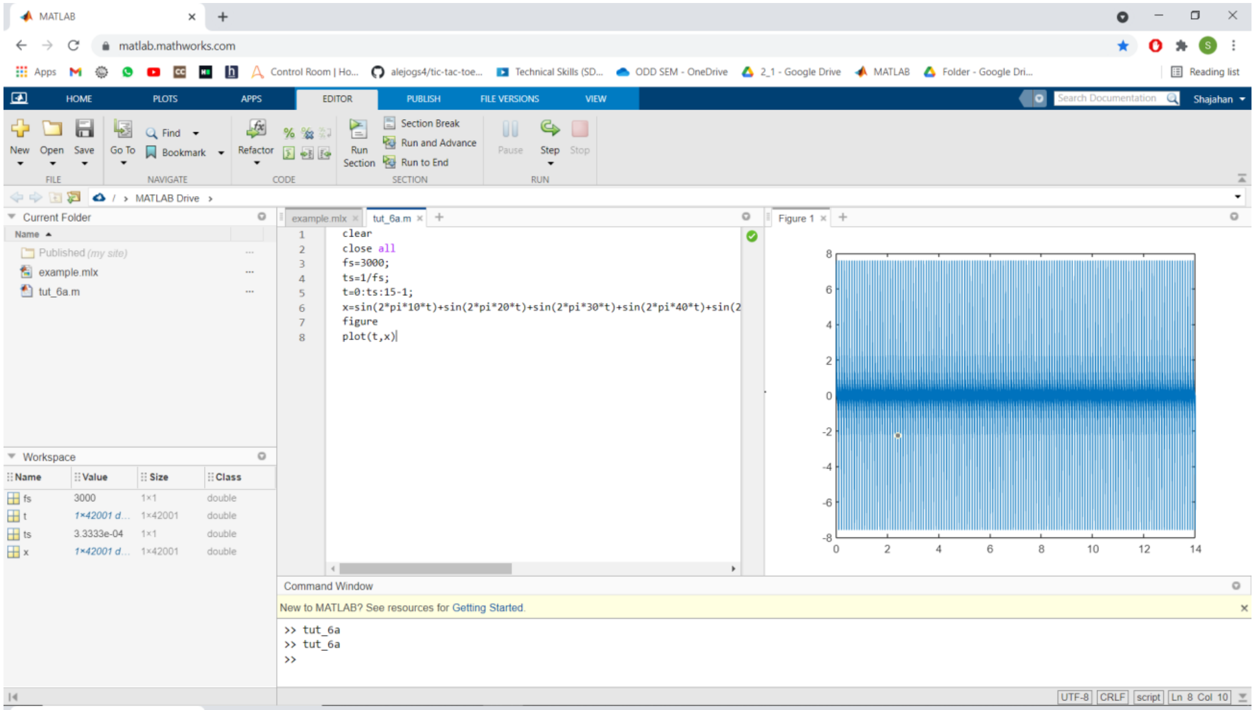
(a) Generate a sinusoidal signal x[n], combination of frequencies10Hz, 20Hz, 30Hz, 40 Hz, 50 Hz, 60 Hz, 70 Hz, 80 Hz, 90 Hz, 100 Hz, for 15 seconds at the sampling frequency of 2000Hz.. Experiment with sampling frequency 3000 hz and 4000 hz. Plot signals for all three sampling frequencies.

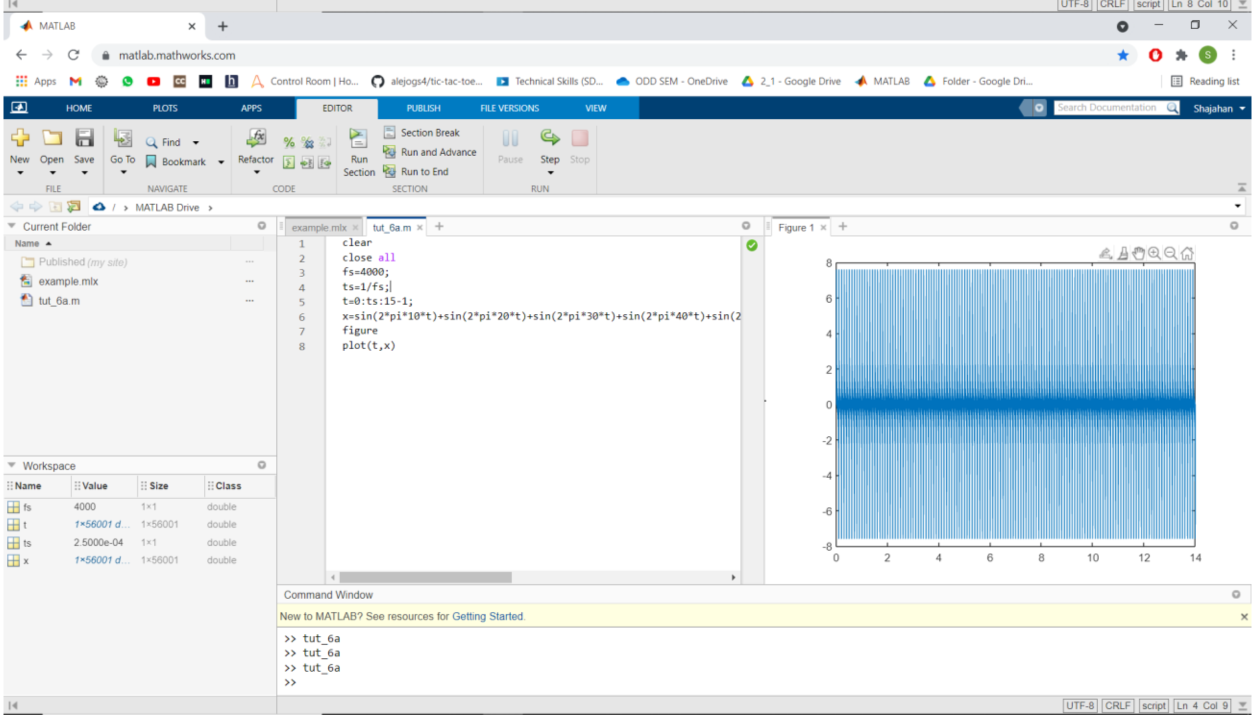
Code:

```
clear
close all
fs=2000;
ts=1/fs;
t=0:ts:15-1;
x=sin(2*pi*10*t)+sin(2*pi*20*t)+sin(2*pi*30*t)+sin(2*pi*40*t)+sin(2*pi*50*t)+sin(2*pi*60*t)+sin(2*pi*70*t)+sin(2*pi*80*t)+sin(2*pi*90*t)+sin(2*pi*100*t);
figure
plot(t,x)
```

output:







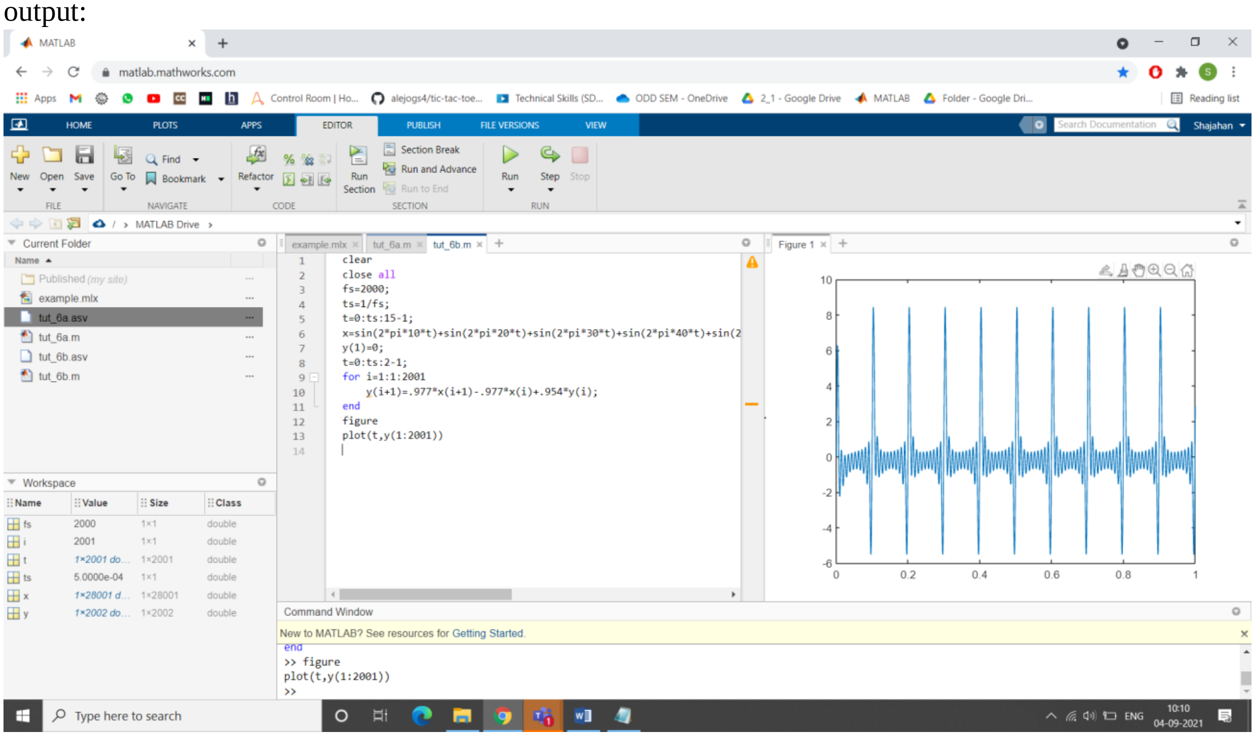
(b) Design a third order high pass IIR filter using bilinear transform method. Take cutoff frequency as 15 Hz. Use analog prototype as 1/(1+s). Plot the filter response y[n].

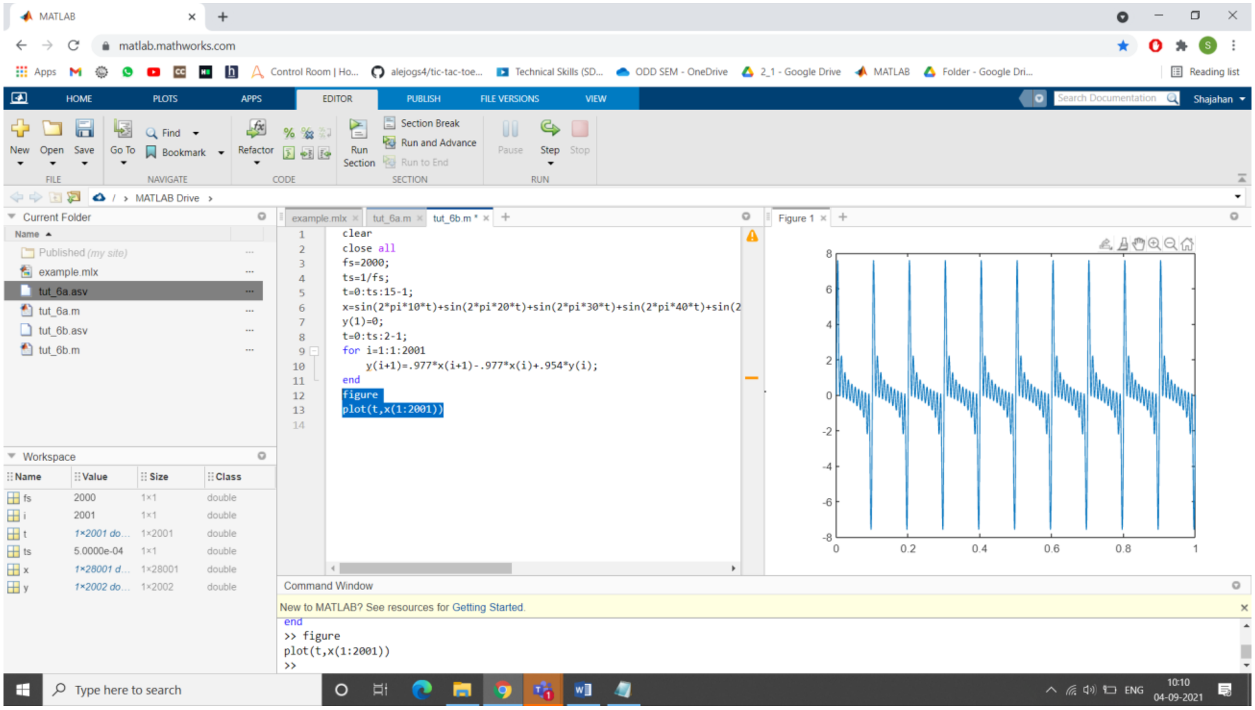
Code:

```
clear
```

```
close all
fs=2000;
ts=1/fs;
t=0:ts:15-1;
x=sin(2*pi*10*t)+sin(2*pi*20*t)+sin(2*pi*30*t)+sin(2*pi*40*t)+sin(2*pi*50*t)+sin(2*pi
*60*t)+sin(2*pi*70*t)+sin(2*pi*80*t)+sin(2*pi*90*t)+sin(2*pi*100*t);
y(1)=0;
t=0:ts:2-1;
for i=1:1:2001
    y(i+1)=.977*x(i+1)-.977*x(i)+.954*y(i);
end
figure
plot(t,x(1:2001))
```

output:





Post Tutorial

(a) Write step by step procedure to design an IIR filter from bilinear transform method

Solution:

Step 1. Obtain the Laplace transfer function Hc(s) for the prototype analog filter in the form.

Step 2. Determine the digital filter's equivalent sampling frequency fs and establish the sample period ts = 1/fs

Step 3. In the Laplace Hc(s) transfer function, substitute the expression

$$\frac{2}{t_s}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)$$

for the variable s to get the IIR filter's H(z) transfer function.

Step 4. Multiply the numerator and denominator of H(z) by the appropriate power of (1 + z–1) and grind through the algebra to collect terms of like powers of z in the form

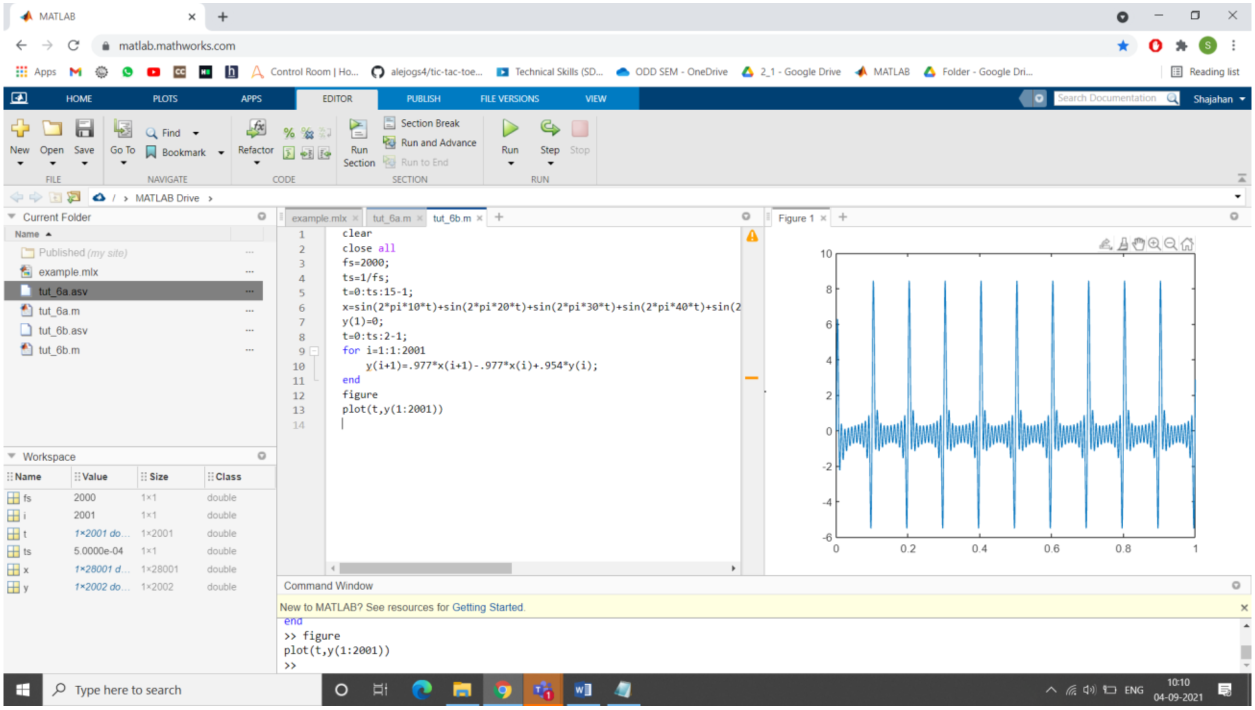
Step 5. Just as in the impulse invariance design methods, by inspection, we can express the IIR filter's time-domain equation in the general form

b.Sate Bilinear transform to Z Transform formulae.
Solution:

This transform avoids the problem of aliasing by using an algebraic transformation between the variables *s* and *z* that map the $j\omega$ axis in the *s* plane to one revolution of the unit circle in the *z* plane. However, neither the impulse response nor the phase response of the analog filter are preserved in the digital filter that is obtained.
The mapping of the continuous-time system to the discrete-time system is accomplished using the following equation:

$$H(z) = H_c\left[\frac{2}{T_d}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)\right]$$

(c) Generate a sinusoidal signal x[n], combination of frequencies10Hz, 20Hz, 30Hz, 40 Hz, 50 Hz, 60 Hz, 70 Hz, 80 Hz, 90 Hz, 100 Hz, for 15 seconds at the sampling frequency of 2000Hz.. Design a third order low pass IIR filter using bilinear transform method. Take cutoff frequency as 15 Hz. Use analog prototype as 1/(1+s). Plot the filter response y[n].



(ForEvaluator'suseonly)

Comment of the Evaluator (if Any)	Evaluator's ObservationMarks Secured: out of ________ FullNameoftheEvaluator: SignatureoftheEvaluator Dateof Evaluation: