Signals and Systems Internal Asscsment (4)

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Q1] Apply Laplace T,

$$y(s) + 2s\,y(s) = 2X(s) + 3s\,X(s) + s^2 X(s)$$

$$y(s)\,(1+2s) = X(s)\,(2+3s+s^2)$$

$$H(s) = \frac{y(s)}{X(s)} = \frac{2+3s+s^2}{1+2s}$$

* now, for causality / non-causality :

numerator = $1+2s$ → degree = 1
denominator = s^2+3s+2 → degree = 2

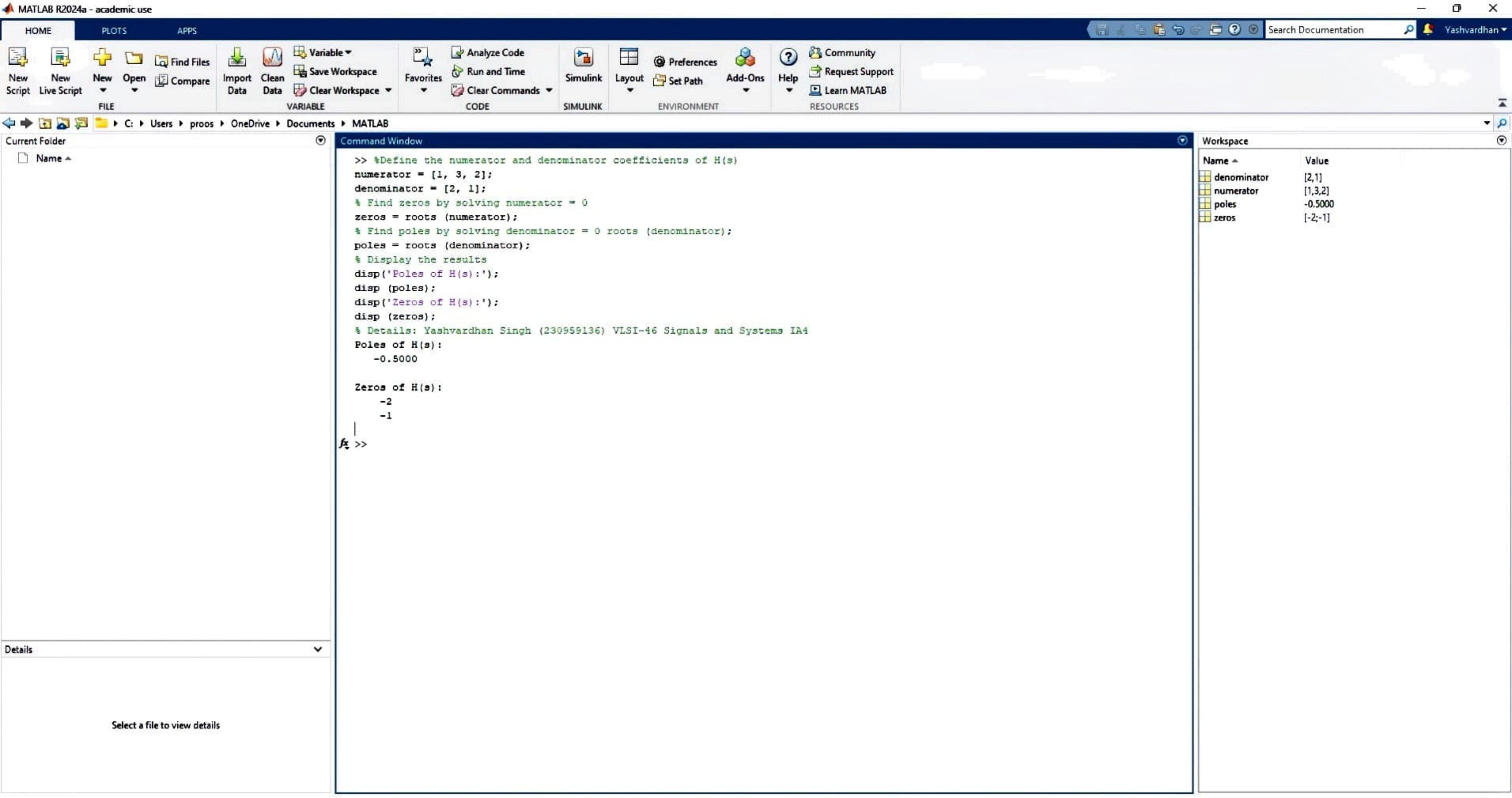
Degree of Denominator > Degree of Numerator
∴ Inverse system is Causal

* for stability / non-stability,
we find roots of denominator

s^2+3s+2

roots : $s=-1$
$s=-2$

Since roots are negative and real, it is STABLE system.


MATLAB R2024a - academic use
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>> %Define the numerator and denominator coefficients of H(s)
numerator = [1, 3, 2];
denominator = [2, 1];
% Find zeros by solving numerator = 0
zeros = roots (numerator);
% Find poles by solving denominator = 0 roots (denominator);
poles = roots (denominator);
% Display the results
disp('Poles of H(s):');
disp (poles);
disp('Zeros of H(s):');
disp (zeros);
% Details: Yashvardhan Singh (230959136) VLSI-46 Signals and Systems IA4
Poles of H(s):
-0.5000
Zeros of H(s):
-2
-1
>>
Workspace
Name
Value
denominator
[2,1]
numerator
[1,3,2]
poles
-0.5000
zeros
[-2;-1]
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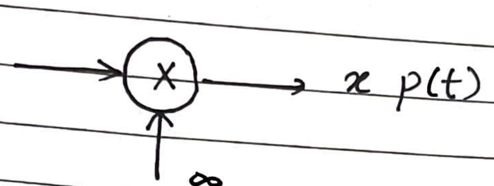
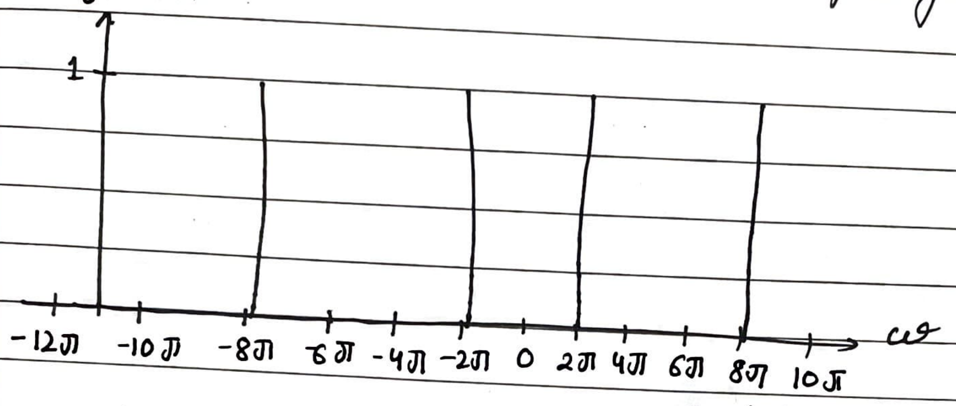
q2]

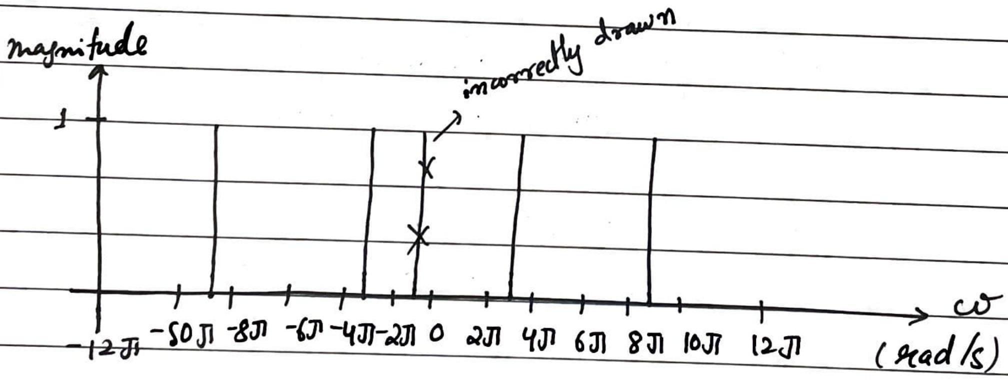


$$p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT) \quad ; \quad T = 1/3$$

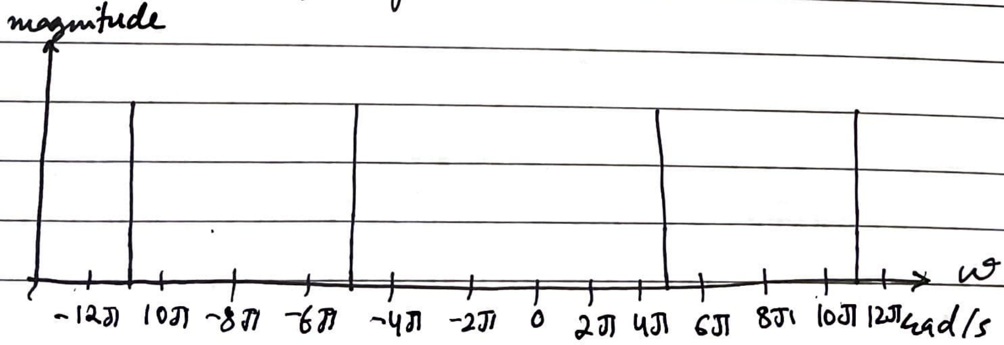
① case one : base band signal is modulated by $\cos(2\pi t)$; spectrum shifts by $\pm 2\pi$



② case 2 : modulation with $\omega_0 = 3\pi$, causing spectrum to shift by $\pm 3\pi$



③ case ③ : modulation with $\omega_0 = 5\pi$, causing spectrum shift by $\pm 5\pi$



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q2.] continued signal can be reconstructed by ideal reconstruction by using formula:

$$X_\delta(j\omega) = \frac{1}{TS} \sum_{k=-\infty}^{\infty} X(j\omega - jk\omega s)$$

Here, the sampling is taken equal to or greater than nyquist's rate:

$$\omega_s \geq 2\omega_0$$

Q3] ROC of a Z-transform is range of values in complex plane for which Z-transform of a discrete time signal converges.

PROPERTIES:

1) ROC does not have any poles
2) If signal is right-sided (causal), ROC is outside outermost pole.
3) If signal is left-sided (anti-causal), ROC is inside innermost pole.
4) ROC is single and continuous region.

$$a[n] = [n(-0.25)^n u(n)] * [(0.5)^{-n} u(-n)]$$

$\therefore$ Z-transform of $na^n u(n) = za/(z-a)^2$

at $a = -0.25$,

$$X_1(z) = \frac{z(-0.25)}{(z+0.25)^2} \Rightarrow ROC: |z| > 0.25$$

$\therefore$ Z-transform of $a^{-n} u(-n) = z/z-a$

$$X_2(z) = \frac{z}{z-0.5} \Rightarrow ROC: |z| < 0.5$$

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q3. continued :

convolution in time domain
is multiplication in z domain

$$\frac{-0.25z}{(z+0.25)^2} \times \frac{z}{(z-0.5)}$$

$\therefore$ ROC : $0.25 < |z| < 0.5$

i) poles : at $z = -0.25$; $z = 0.5$
ii) zeroes : at $z = 0$
iii) $0.25 < |z| < 0.5$