Experiment No 04

BECS 32461

Paper D

**IMPLEMENTATION OF Z-TRANSFORM AND INVERSE Z-TRANSFORM**

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**PROCEDURE**

F01.

b = 0.2;

a = [1, -0.52, 0.68];

H = tf(b, a, -1);

disp('Transfer Function H(z):'); H

figure;

zplane(b, a);

title('Pole-Zero Plot of H(z)');

grid on;

A graph of a circle with a number of points

AI-generated content may be incorrect.

A white background with black text

AI-generated content may be incorrect.

F02.

b = 0.2;

a = [1, -0.52, 0.68];

H = tf(b, a, -1);

disp('Transfer Function H(z):'); H

figure;

stepz(b, a);

A graph showing a step response

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F03.

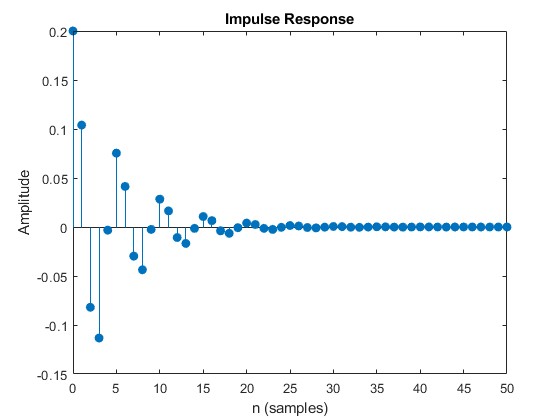
b = 0.2;

a = [1, -0.52, 0.68]; s

H = tf(b, a, -1);

disp('Transfer Function H(z):'); H

impz(b, a);



F04.

b = 0.2;

a = [1, -0.52, 0.68];

w = linspace(0, pi, 500);

[h, w] = freqz(b, a, w);

magH = abs(h);

phaH = angle(h) \* 180/pi;

poles = roots(a);

disp('Poles of H(z):');

disp(poles);

subplot(2,1,1);

plot(w/pi,magH, 'r-', 'LineWidth', 1.5)

xlabel("|H|")

ylabel("Frequency (in pi units)")

title('Magnitude Response of H(z)');

subplot(2,1,2);

plot(w/pi,phaH, 'm-', 'LineWidth', 1.5)

xlabel("Degrees")

ylabel("Frequency (in pi units)")

title('Phase Response of H(z)'); A diagram of a phase response

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**EXERCISE**

E01.

a.

b = [1, -0.6,0];

a = [1, -0.5, 0.2];

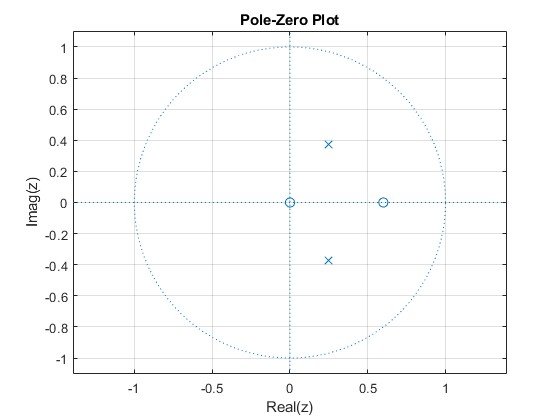
figure;

zplane(b, a);

title('Pole-Zero Plot');

xlabel('Real(z)'); ylabel('Imag(z)');

grid on;



b.

b = [1, -0.6 ,0];

a = [1, -0.5, 0.2];

w = linspace(0, pi, 500);

[h, w] = freqz(b, a, w);

magH = abs(h);

phaH = angle(h) \* 180/pi;

subplot(2,1,1);

plot(w/pi,magH, 'm--', 'LineWidth', 1.5)

xlabel("|H|")

ylabel("Frequency (in pi units)")

title('Magnitude Response of H(z)');

subplot(2,1,2);

plot(w/pi,phaH, 'b-', 'LineWidth', 1.5)

xlabel("Degrees")

ylabel("Frequency (in pi units)")

title('Phase Response of H(z)');

A diagram of a function

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c.

b = [1, -0.6 ,0];

a = [1, -0.5, 0.2];

n = 0:49;

x = sin(0.1\*pi\*n);

y = filter(b, a, x);

figure;

plot(n, y, 'g-', 'LineWidth', 1.2); hold on;

plot(n, x, 'b--', 'LineWidth', 1.0);

title('Input and Output');

xlabel('n');

ylabel('Amplitude');

legend('output','input');

grid on;

A graph of a function

AI-generated content may be incorrect.

E02.

a.

b = [4, 3, 2, 0.5, 1.5];

a = [1, 6, 8, 2, 0.6];

[R, P, K] = residuez(b, a);

fprintf('Residues (R):\n'); disp(R);

fprintf('Poles (P):\n'); disp(P);

fprintf('Direct terms (K):\n'); disp(K);

A screenshot of a computer

AI-generated content may be incorrect.

b.

b = [4, 3, 2, 0.5, 1.5];

a = [1, 6, 8, 2, 0.6];

figure;

zplane(b, a);

title('Pole-Zero Plot of G(z)');

xlabel('Real(z)'); ylabel('Imag(z)');

grid on;

A graph of a graph with a circle and x

AI-generated content may be incorrect.

c.

b = [4, 3, 2, 0.5, 1.5];

a = [1, 6, 8, 2, 0.6];

p = roots(a);

mag\_p = abs(p);

fprintf('Poles:\n'); disp(p);

fprintf('Magnitudes:\n'); disp(mag\_p);

if all(mag\_p < 1)

fprintf('\nResult: System is STABLE (all |p| < 1).\n');

elseif any(mag\_p > 1)

fprintf('\nResult: System is UNSTABLE (some |p| > 1).\n');

else

fprintf('\nResult: MARGINAL (some pole(s) lie on the unit circle: |p| == 1).\n');

end

A screenshot of a computer

AI-generated content may be incorrect.

d.

b = [4, 3, 2, 0.5, 1.5];

a = [1, 6, 8, 2, 0.6];

n = 0:20;

[h, nout] = impz(b, a, n);

figure;

stem(nout, h, 'filled');

title('Impulse Response of G(z)');

xlabel('n');

ylabel('h[n]');

grid on;

A graph of a function

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E03.

a.

syms z n

Hz = (1 + 2\*z^-1 + 3\*z^-2) / (1 - 1.2\*z^-1 + 0.8\*z^-2);

x\_n = iztrans(Hz, z, n);

x\_n\_simpl = simplify(x\_n);

fprintf('Symbolic inverse Z-transform x[n] = \n');

disp(x\_n\_simpl);

Symbolic inverse Z-transform x[n] =

(15\*kroneckerDelta(n, 0))/4 + (16\*(-1)^n\*4^n\*cos(n\*(pi - acos((3\*5^(1/2))/10))))/(3\*(2\*5^(1/2))^n) + ((-1)^n\*5^(1 - n)\*11^(1/2)\*(- 3 - 11^(1/2)\*1i)^(n - 1)\*97i)/66 - ((-1)^n\*5^(1 - n)\*11^(1/2)\*(- 3 + 11^(1/2)\*1i)^(n - 1)\*97i)/66

b.

b = [1, 2, 3];

a = [1, -1.2, 0.8];

figure;

zplane(b, a);

title('Pole-Zero Plot of H(z)');

xlabel('Real(z)'); ylabel('Imag(z)');grid on;

A graph of a circle with blue dots

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c.

b = [1, 2, 3];

a = [1, -1.2, 0.8];

[R, P, K] = residuez(b, a);

fprintf('Residues (R):\n'); disp(R);

fprintf('Poles (P):\n'); disp(P);

fprintf('Direct terms (K):\n'); disp(K);

[num, den] = residuez(R, P, K);

fprintf('Reconstructed numerator (z^-1 coeffs):\n'); disp(num);

fprintf('Reconstructed denominator (z^-1 coeffs):\n'); disp(den);

A screenshot of a computer program

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d.

System is STABLE (all |p| < 1)

E04.

r\_outer = 2.0;

x\_inner = r\_inner \* cos(theta); y\_inner = r\_inner \* sin(theta);

x\_outer = r\_outer \* cos(theta); y\_outer = r\_outer \* sin(theta);

ux = cos(theta); uy = sin(theta);

figure;

hold on;

axis equal;

fill([x\_inner, fliplr(x\_outer)], [y\_inner, fliplr(y\_outer)], 'y','FaceAlpha', 0.35, 'EdgeColor', 'none');

plot(ux, uy, 'm--', 'LineWidth', 1.5);

xlabel('Real(z)');

ylabel('Imag(z)');

title('Unit circle and ROC for x[n] = - (0.3)^n, 0 \le n \le 20');

legend('ROC','Unit circle |z|=1');

grid on;

xlim([-r\_outer r\_outer]); ylim([-r\_outer r\_outer]);

A yellow circle with a pink dotted line

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The Region of Convergence (ROC) is the set of complex -values where the Z-transform sum converges to a finite value. Its shape (outside a radius, inside, or an annulus) depends on whether the sequence is finite, right-sided, or left-sided, and the ROC never includes poles where the transform blows up. ROC matters for stability because an LTI system is BIBO-stable only if its ROC includes the unit circle , which guarantees the frequency response exists and bounded inputs produce bounded outputs.