**Task1**

t=-5:.01:5;

x=heaviside(t)-heaviside(t-1);

y\_1 = 3 \* x; % static cuzx(t)is same

y\_2 = heaviside(t-1)-heaviside(t-1-1);

subplot(311)

plot (t,x)

subplot(312)

plot (t,y\_1)

subplot(313)

plot (t,y\_2)

**Task2**

n = -1:3;

x = [0 1 2 3 4];

subplot(311)

stem(n,x)

legend('x[n]')

subplot(312)

y\_1 = x.^2;

stem(n,y\_1);

legend('y\_1[n]')

a = 1/2;

x1 = upsample(x,1/a)

n1=-2:7;

stem(-2:7,x1)

legend('x[n]','y\_2[n]')

**Task3**

a)

t = -3:0.1:3;

x1 = heaviside(t) - heaviside(t - 2);

x2 = x1;

a1 = 2; a2 = 3;

y1\_combined = 2 \* (a1\*x1 + a2\*x2);

y1\_individual = a1 \*(2\*x1) + a2\*(2\*x2);

figure;

subplot(2,1,1);

plot(t, y1\_combined);

subplot(2,1,2);

plot(t, y1\_individual)

% Conclusion: System y = 2x(t) is

linear (superposition holds)

b)

y2\_combined = (a1\*x1 + a2\*x2).^2;

y2\_individual = a1\*(x1.^2) + a2\*(x2.^2);

figure;

subplot(2,1,1);

plot(t,y2\_combined);

subplot(2,1,2);

plot(t, y2\_individual)

% Conclusion: System y = x²(t) is

nonlinear (superposition fails)

**Task4**

% Task 4(a) - System y = 2^x

n = 0:5;

x1 = 0.8 \* n;

x2 = cos(n);

a1 = 2; a2 = 3;

y\_combined = 2.^(a1\*x1 + a2\*x2);

y\_individual = a1\*2.x1 + a2\*2.^x2;

figure;

subplot(2,1,1);

stem(n, y\_combined); grid on;

subplot(2,1,2);

stem(n, y\_individual)

% Conclusion: System y[n] = 2^{x[n]} is

nonlinear (superposition fails)

**% Task 4(b) - System y = n \* x[n]**

y\_combined = n .\* (a1\*x1 + a2\*x2);

y\_individual = a1\*(n.\*x1) + a2\*(n.\*x2);

figure;

subplot(2,1,1); stem(n, y\_combined)

subplot(2,1,2); stem(n, y\_individual)

Conclusion: System y[n] = n·x[n] is linear (superposition holds)

**Task7**

t = -10:0.01:10;

x = cos(2 \* pi \* t);

% S1:

y1 = x.^2;

% S2:

y2 = t .\* x

figure;

subplot(3,1,1); plot(t, x);

subplot(3,1,2); plot(t, y1);

subplot(3,1,3); plot(t, y2);

% Conclusion:

% System 1 is nonlinear — violates

superposition principle due to nonlinearity

of squaring.

% System 2 is linear — satisfies

superposition and homogeneity,

hence linear.

**Task6**

t = -5:0.01:15;

x = cos(t) .\* (heaviside(t) - heaviside(t - 10));

y = 1-2\*cos(t-1).\*(heaviside(t-1)-heaviside(t-11));

x\_shifted = cos(t-2).\*(heaviside(t-2)-heaviside(t-12));

y\_shifted\_input = 1-2\*cos(t-3).\*(heaviside(t-3)-heaviside(t- 13));

figure;

subplot(2,1,1); plot(t, y\_shifted\_input);

subplot(2,1,2); plot(t, y);

% Conclusion: System is time-variant

**Task 5**

t = -2:0.01:10;

t0 = 2;

x = heaviside(t) - heaviside(t - 5);

y = t .\* exp(-t) .\* x;

x\_shifted = heaviside(t - t0) - heaviside(t - t0 - 5);

y\_shifted\_input = t .\* exp(-t) .\* x\_shifted;

y\_time\_shifted = (t - t0) .\* exp(-(t - t0)) .\* x\_shifted;

figure;

subplot(2,1,1);

plot(t, y, 'b'); hold on;

plot(t, y\_shifted\_input, 'r');

legend('Original Output', 'Shifted Input Output'); grid on;

subplot(2,1,2);

plot(t, y\_time\_shifted, 'g');

legend('Time-Shifted Output'); grid on;

% Conclusion: System is time-invariant (y(t - t0) matches output for shifted input)