EE 311 **January 13, 2016**
Chapter 2 Problems

2.2. Write a MATLAB® program to generate a plot of $u[n-4]-u[n-10]$ over the discrete sequence $0 \le n \le 15$.

Solution

```
for m=1:16
  y(m)=0;
  n=m-1;
  k(m)=n;
  if n-4>=0, y(m)=1;
  end
  w(m)=0;
  if n-10>=0, w(m)=1;
  end
  x(m)=y(m)-w(m);
end
stem(k,x)
```

2.3. The trapezoidal rule for numerical integration is shown in Figure P2.3. The value of the integral at time nT is equal to the value at (n-1)T plus the area of the trapezoid shown.
(a) Write a difference-equation model for the integration operation that relates y[n] to x[n].
(b) Write a MATLAB program that integrates e^{-t}, $0 \le t \le 5$ seconds, with a sampling period of $T = 0.1$ second.

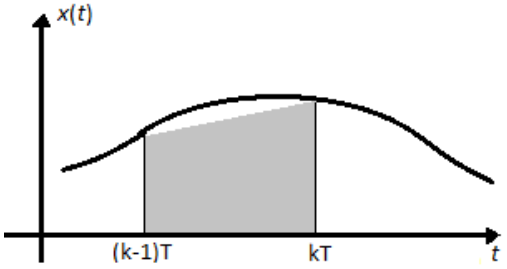


Figure P2.3

Answer

(a) $y[n] = y[n-1] + \frac{T}{2}\left(x[n] + x[n-1]\right)$

(b)

```
y(1)=0;
T=0.1;
for n=1:51
  y(n+1)=y(n)+T/2*(exp(-n*T)+exp(-(n-1)*T));
end
y
```

Final result: $y(5) \approx y[51] = 0.9941$.

2.9. The general case of a signal transformed in both time and amplitude can be expressed as

$$y[n] = Ax[an+b] + B$$

where a is rational and b is an integer. Solve this expression for $x[n]$ in terms of $y[n]$.

Answer

$$y[n] = Ax[an+b] + B;\ \text{let } m = an+b \Rightarrow n = \frac{m-b}{a},$$

$$x[n] = \frac{1}{A} y\left[\frac{m-b}{a}\right] - \frac{B}{A}$$

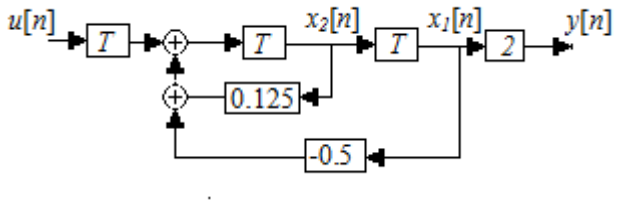
2.24. Sketch a block diagram for a system that will solve the difference equations:

$$x_1[n+1] = x_2[n]$$

$$x_2[n+1] = -0.5x_1[n] + 0.125x_2[n] + u[n]$$

$$y[n] = 2x_1[n]$$

Answer



2.27. (a) Consider two LTI systems connected in cascade. The impulse responses of the two systems are identical, with $h_1[n] = h_2[n] = (0.8)^n$. Find the impulse response of the total system.

(b) Repeat part (a) for $h_1[n] = h_2[n] = \delta[n\text{-}3]$.

Answer

(a) $h[n] = h_1[n] * h_2[n] = \sum_{k=-\infty}^{\infty} 0.8^k u[k] \times 0.8^{n-k} u[n-k] = \sum_{k=0}^{n} 0.8^k \times 0.8^{n-k} = n0.8^n u[n]$

(b) $h[n] = \delta[n-3] * \delta[n-3] = \delta[n-6]$

2.30. The impulse response of a LTID system is $h[n] = (0.5)^{n-1}(u[n] - u[n-2])$. The input signal is $x[n] = \delta[n] + \delta[n-1]$.

(a) Is the system causal?
(b) Is the system stable?

Answer

(a) The system is causal. The response is determined by present and past inputs.

(b) The system is stable. The impulse response decays to zero with increasing time and it is time limited.