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Signals and Systems

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Homework #2

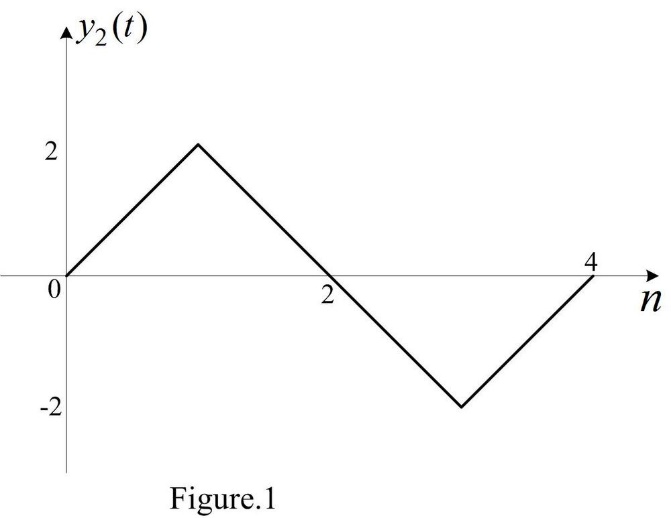
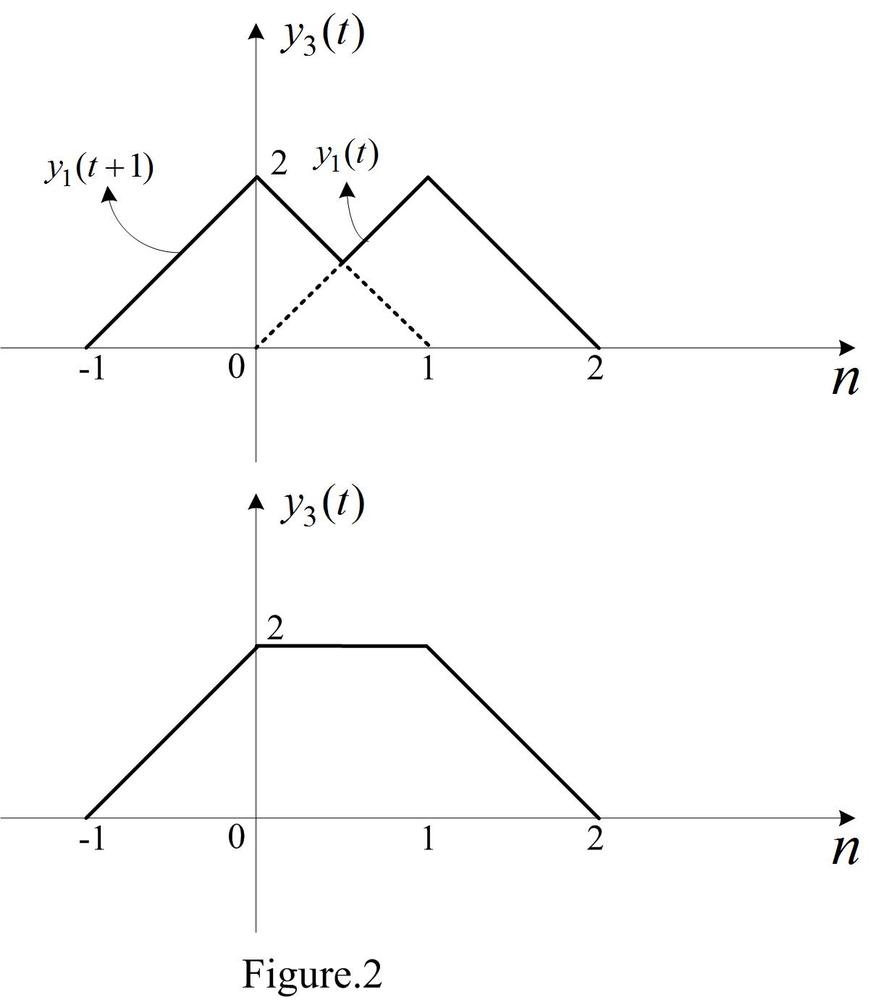
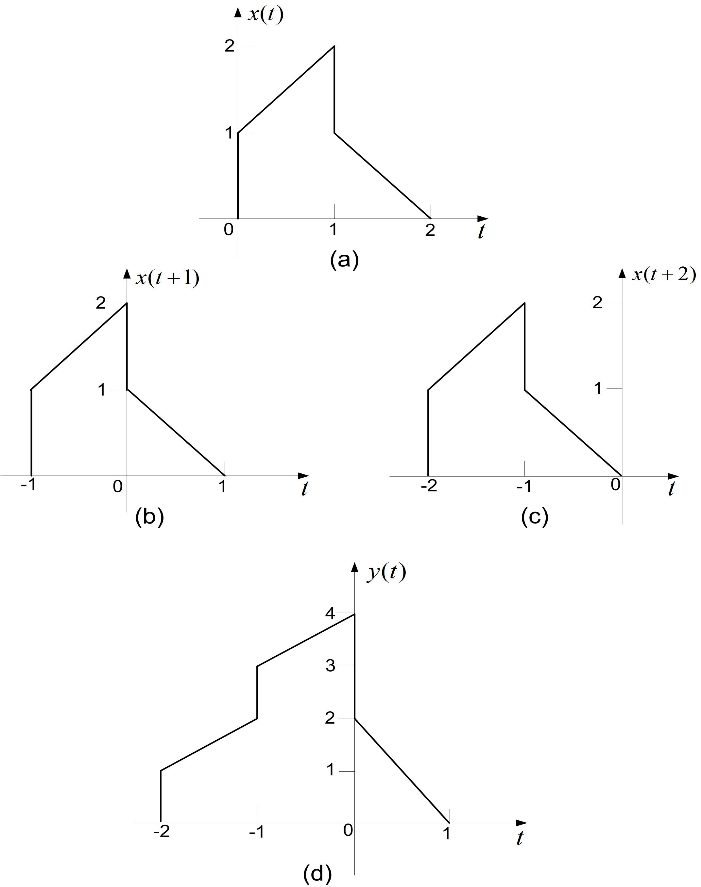
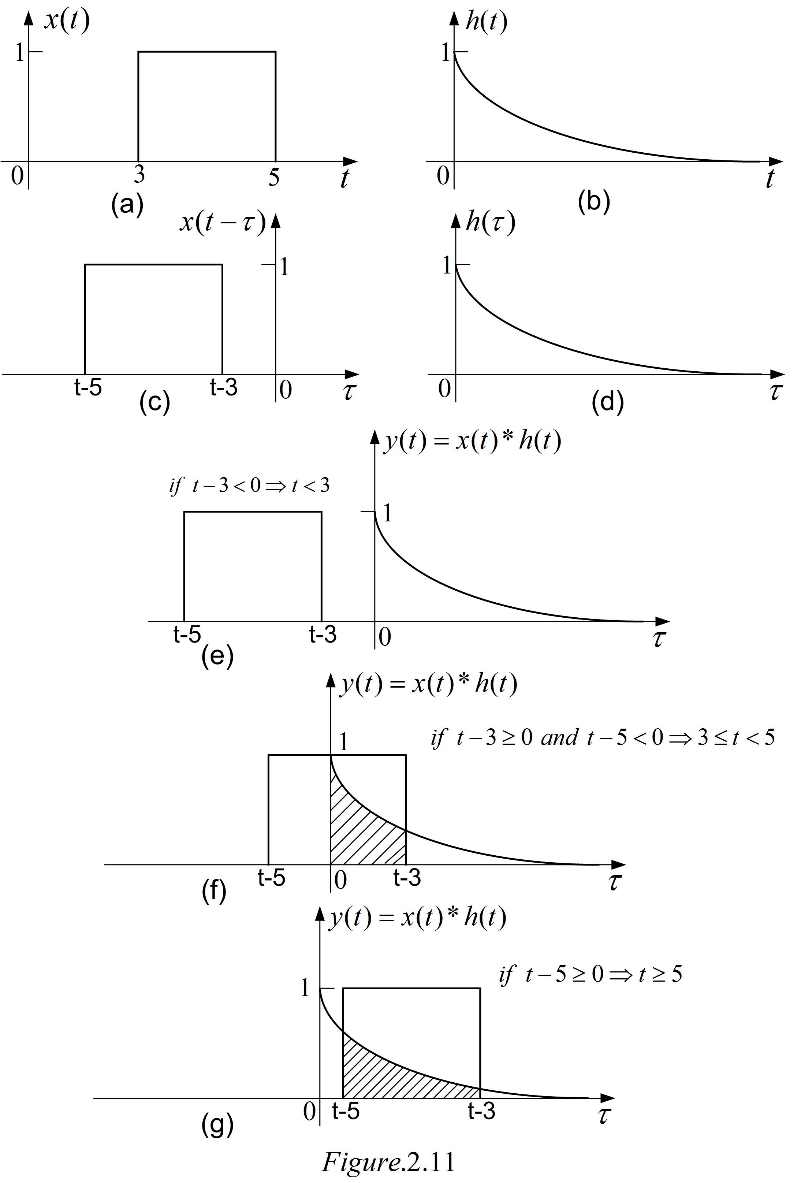
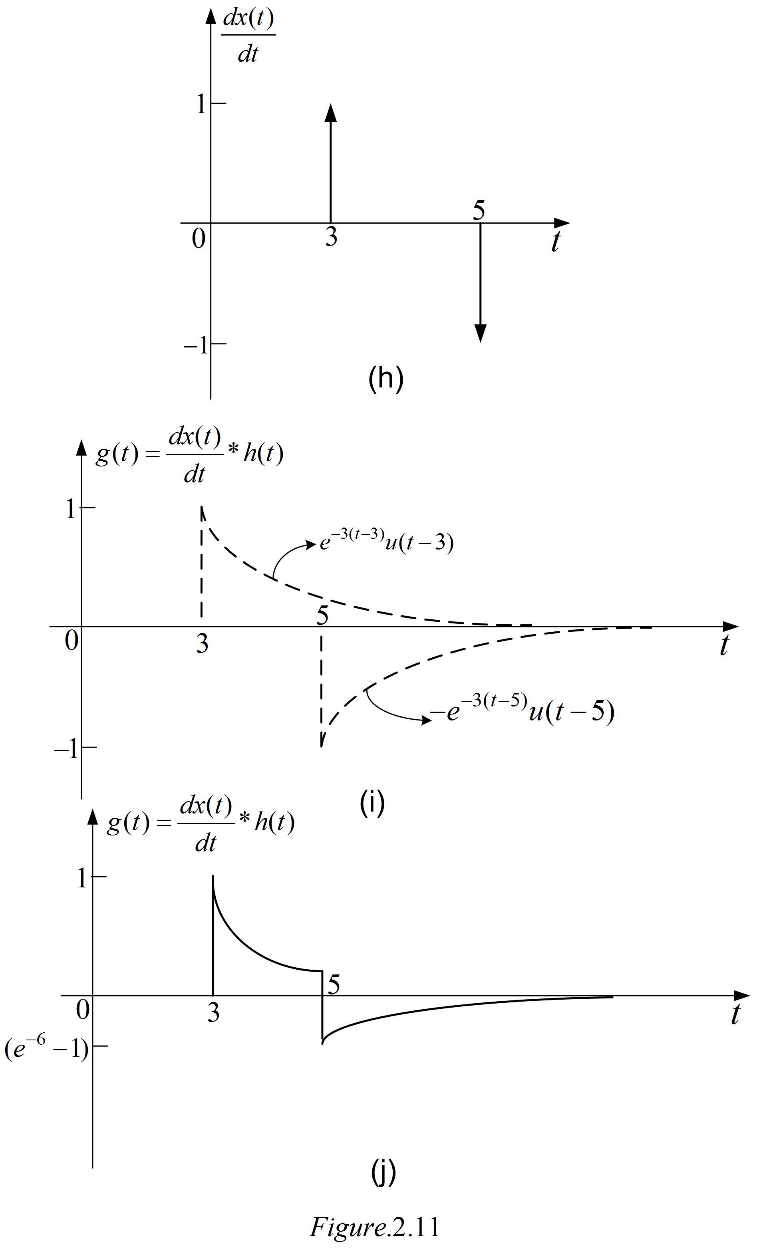
1. Q1.27 (a,f)
   * 1. The **Linear (3)** and **Stable (5)** properties hold for this Continuous-Time System. To determine this:

First, we consider the output at t=0:  
The output y(0) is dependent upon the past value, x(-2), and the future value, x(2). Therefore, by definition, this system cannot be **Causal** and it has **Memory**.

Next, we consider a shift t0 in the output y(t):  
If the input is shifted to t0 and passed through the system, then the output is:  
From this, it is clear that a shift of t0 in the output doesn’t have a corresponding shift in the input. Therefore, this system is **Time-Variant**.

Then, we apply the superposition principle to verify the linearity of the system. Let’s consider:  
We then consider a third input x3(t) such that x3(t) is a linear combination of x1(t) and x2(t):  
Thus, the output y3(t) is given as:  
From this, it is clear that this system satisfies both Additivity and Homogeneity properties, therefore this system is **Linear**.

Finally, let’s consider for all t, then:  
From this, it is clear that this system is **Stable**.

1. The **Linear (3)** and **Stable (5)** properties hold for this Continuous-Time System. To determine this:  
   First, we consider the output at t=0:  
   The output, y(3) at t=3, is dependent upon the past value, x(1). The output, y(-3) at t=-3, is dependent upon the future value, x(-1). Therefore, by definition, this system cannot be **Causal** and has **Memory**.  
     
   Next, we consider a shift t0 in the output y(t):  
   If the input is shifted to t0 and passed through the system, then the output is  
   From this, it is clear that a shift of t0 in the output does not have a corresponding shift in the input, which implies that the system is **Time-variant**.  
     
   Then, we apply the superposition principle to verify the linearity of the system. Let’s consider:  
   Let’s now consider a third input x3(t) such that x3(t) is a linear combination of x1(t) and x2(t):  
   Thus, the output y3(t) would be given as:  
   From this, it is clear that this system satisfies both Additivity and Homogeneity properties. Therefore, this system is **Linear**.  
     
   Finally, let’s consider for all t, then:  
   As , the time scaled version of x(t) will only spread the signal over time, but it is still stable. Therefore, this system is **Stable**.
2. Q1.31
   1. Given a Linear Time-Invariant (LTI) system whose response to an input signal x1(t) is y1(t). That is, . From the input x2(t) depicted in P1.31c, the signal x2(t) can be written in terms of x1(t):  
      Because x1(t) is linear and time-invariant, the output y2(t) of signal x2(t) is:  
      Thus, the signal y2(t) can be depicted below:
   2. From the input x3(t) depicted in P1.31d, the signal x3(t) can be written in terms of x1(t):  
      Because x2(t) is linear and time-invariant, the output y3(t) of signal x3(t) is:  
      Thus, the signal y3(t) can be depicted below:
3. Q2.8
   1. Given this information, we can determine y(t) using the convolution y(t)=x(t)\*h(t):  
      Now, let’s consider x(t+2):  
      Similarly, let’s consider x(t+1):  
      Therefore, is given as:  
      x(t) is plotted below in graph (a). x(t+2) and x(t+1) are plotted below in graphs (b) and (c) respectively. The convolution y(t) is plotted below in graph (d):
4. Q2.11
   1. Given:  
      The convolution is given by:  
      We then plot x(t), h(t), x(t-𝜏), h(𝜏) below in graphs (a), (b), (c), and (d) respectively:  
        
      For t-3<0, y(t)=0. That is .For t-3≥0 & t-5<0:  
      For t-5≥0:That is, convolution y(t) is as follows:
   2. To compute g(t), we first consider :  
      This signal, , is plotted below:  
        
      Next, we plug back into g(t):  
      Therefore, we can write g(t) as:
   3. We can see that y(t) calculated in part (a) is related to g(t) calculated in part b as:
5. Q2.19 (a)
   1. Given S1 is Causal LTI with output response:  
      and S2 is Causal LTI with output response:  
      Let’s rewrite:  
      Next:  
      Substituting, we get:  
      On comparing the above 2 equations, we solve for α and β: