Example of piece-wise functions in MATLAB

Example 1:

Assume $s(t)$ in the following equation is single period version of a periodic signal $\bar{s}(t)$. The signal $\bar{s}(t)$ has frequency of $1/5$.

$$s(t) = \begin{cases} 
0, & 0 < t \leq 1 \\
1, & 1 < t \leq 2 \\
\exp(-t), & 2 < t \leq 5
\end{cases}$$

The following MATLAB code can be used to plot $s(t)$. The plot is presented following the code.

```matlab
Freq = 1/5; %Sets the frequency of source.
T = 1/Freq; %Calculates the period of the source.
t = 0:0.1:T; %Defines vector t with 10T+1 elements from 0-T.
s = zeros(size(t)); %Loads a vector s with zeros.
for i = 1:length(t) %Indexes i from 1 to 10T+1.
    if t(i)<1 %The next step is carried out if t is less than one.
        s(i) = 0; %Sets the value of s to 0, redundant with Step 4.
    elseif 1<=t(i)& t(i)<2 %Performs a logical operation (& = AND) to determine if the value of t is equal to or greater than 1 and less than 2. If so, the next step will be performed.
        s(i) = t(i) - 1; %Sets the value of s to t - 1 where 1<=t<2.
    else
        s(i) = exp(-t(i)-2)); %Otherwise, s is set to e raised to -1*(t-2)
    end
end %Two 'end' statements are needed. One to end the for loop and the other to end the if/elseif/else statement.
figure(1) %Names the figure
plot(t,s); %Draws a plot where t is the x-axis and s(t) is the y-axis
title('s(t) vs t') %Inserts a title on the plot
xlabel('time (seconds)'); %Inserts a x-axis label on the plot
ylabel('s(t)'); %Inserts a label for the y-axis
grid on %Causes a grid to appear on the plot
```
The code can be modified as follows to plot \( s(t) \) for the first 4 full periods.

```matlab
Freq = 1/5; % frequency of source
T = 1/Freq; % period
t = 0:0.1:T;
s = zeros(size(t));

for i = 1:length(t)
    if t(i)<1
        s(i) = 0;
    elseif 1<=t(i)&t(i)<2
        s(i) = t(i)-1;
    else
        s(i) = exp(-(t(i)-2));
    end
end

figure(1)
plot(t,s);
title('s(t) vs t')
xlabel('t');
ylabel('s(t)');
grid on
```

It should not be assumed that \( d \) will have the same value in between copies of the waveform.
\[ d = t(2) - t(1); \quad \% \text{time gap between successive samples} \]
\[ sp = [s \ s \ s \ s]; \quad \% \text{concatenating 4 s(t)'s next to each other} \]

This is proof of the issue. \( s(t) \) contains samples at both time 0s and time 5s. In the periodic wave, these samples should overlap, making \( d = 0 \) between the samples instead of 0.1s. Concatenating in this fashion (in combination with the next line that sets all time steps evenly) has effectively lengthened the period to 5.1s.

\[ t = (1:length(sp)) \times d; \quad \% \text{the new time range to accommodate 4 periods} \]

If the samples were evenly spaced, this would need to be \((0:length(sp) - 1) \times d\).

The entire wave is being shifted by \( d \) seconds (.1s).

```
figure(2)
figure(1)
plot(t,sp);
title('sp(t) vs t')
xlabel('t');
ylabel('sp(t)');
grid on
```

The error due to the offset and lengthened period can be seen in the graph. The last sample should be at 20s.