

**Total: \_\_\_\_/20**

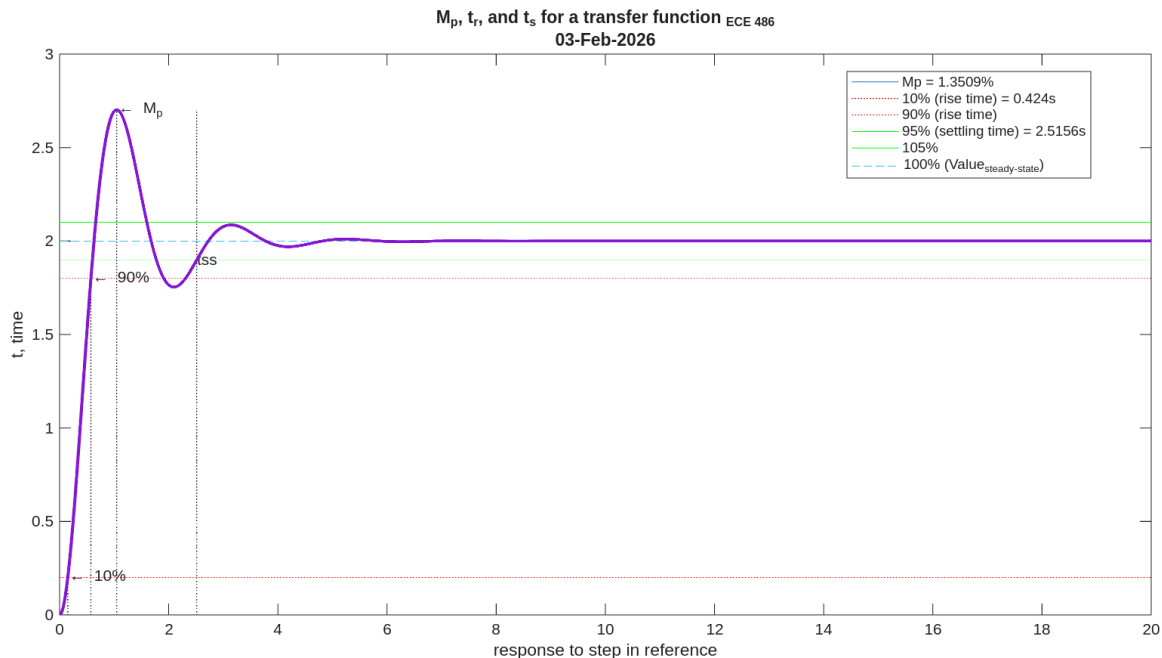
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**Report Guidelines:****\_\_\_\_/20**

For this report you will need three files:

- 1.) LabReport0.m (the main file that runs the other two)
- 2.) StepResponseMetrics.m (a file you will edit to show  $M_p$ ,  $t_r$  and  $t_{ss}$ )
- 3.) controllerlab0.mdl (A SIMULINK model)

All three files must be saved in the same directory. You only need to edit StepResponseMetrics.m. You can run all three by typing **LabReport0** in the Matlab command window because LabReport0.m calls the other two files.

**What to hand in:**

```

1  % -----%
2  % [Mp, tr, ts,MpIndex, t_10index,t_90index,tssIndex] =
3  % StepResponseMetrics(y,t, yStartIndex, ssVal)
4  %
5  % DESCRIPTION:
6  % function StepResponseMetrics determines the overshoot,
7  % rise-time, and steady-state time for a step input signal.
8  %
9  %INPUTS:
10 % y : a 1 dimensional array of the response
11 % t : an array of the time (in seconds)
12 % yStartIndex : (integer) the array index when the step input begins
13 % ssVal : the steady state value that y approaches
14 %
15 %OUTPUTS:
16 %Mp : overshoot percent
17 %tr : rise time for the signal 10-90%
18 %ts : time from
19 %MpIndex: index of the time array where it is maximum
20 %t_10index: index of the time array where it is first at 10% of signal
21 %t_90index: index of the time array where it is first at 90% of signal
22 %tssIndex: index of the time array where it is at steady-state
23 % -----%
24 function [Mp, tr, ts,MpIndex, t_10index,t_90index,tssIndex] = StepResponseMetrics(y,t,
yStartIndex, ssVal)
25
26 % calculate Mp, tr, ts:
27
28 %Mp
29 % Hint: remember that Mp is the maximum reponse -- so you can use max(y)
30 % to get the maximum response
31 [MaxResponse,MpIndex] = max(y);
32 % Mp is the percentage overshoot -- so if the steady state value is 5.0 and
33 % the maximum response is 7.5, Mp = 50%. If the maximum response was 4.9,
34 % Mp is 0.
35 Mp = MaxResponse / ssVal;
36
37 %tr
38 % tr is the time required for the response to rise from 10% of the
39 % steady-state value to 90% of the steady-state value. The function 'find'
40 % is useful here. Type "helpwin find" to see how it works.
41 t_10index = find( y > .1*ssVal, 1, 'first');
42 % I've done the 10% index, you do the 90%:
43 t_90index = find( y > 0.9*ssVal, 1, "first");
44 tr = t(t_90index )-t(t_10index );
45
46
47 %ts
48 % ts is the time it takes for the response settle between 95% and 105% of
49 % the steady-state value. One way to find ts is to use a while loop,
50 % initialize a counter (x) to the end of the response array, and move
51 % forwards through the array until the response is no longer within the
52 % 95-105% bounds.
53 x = length(y); %initialize x to the end of the array
54 while y(x) > 0.95*ssVal && y(x) < 1.05*ssVal
55     x = x - 1;
56 end
57 ts = t(x)-t(yStartIndex);
58 tssIndex = x;
59
60 % -----%

```

```

61 %                                PLOTTING THE DATA                                %
62 % ----- %
63 figure %open a new figure pane
64 ss = 1:1:numel(t); % the final value
65 ss(:) = ssVal;
66 per105=1.05*ss;
67 per95=.95*ss;
68 per10=.10*ss;
69 per90=.90*ss;
70
71 %plot the response and the bounds for 10%, 90%, 95% and 105%
72 plot(t,y,'-',t,per10,':r',t,per90,':r',t,per95,'-g',t,per105,'-g',t,ss,'--')
73
74 %add a legend
75 legend(['Mp = ',num2str(Mp), '%'],...
76         ['10% (rise time) = ',num2str(tr), 's'],...
77         '90% (rise time)',...
78         ['95% (settling time) = ', num2str(ts), 's'],...
79         '105% ',...
80         '100% (Value_{steady-state})','Location','Best')
81
82 % document Mp
83 if(Mp > 0)
84     text(t(MpIndex),y(MpIndex),'\leftarrow M_p',...
85          'HorizontalAlignment','left')
86     line([t(MpIndex);t(MpIndex)],[0,y(MpIndex)],...
87          'Color','k','LineWidth',0.5,'LineStyle',':', 'HandleVisibility', 'off')
88 end
89 %document tr
90 text(t(t_10index),y(t_10index),'\leftarrow 10%',...
91      'HorizontalAlignment','left')
92 line([t(t_10index);t(t_10index)],[0,y(t_10index)],...
93      'Color','k','LineWidth',0.5,'LineStyle',':', 'HandleVisibility', 'off')
94
95 text(t(t_90index),y(t_90index),'\leftarrow 90%',...
96      'HorizontalAlignment','left')
97 line([t(t_90index);t(t_90index)],[0,y(t_90index)],...
98      'Color','k','LineWidth',0.5,'LineStyle',':', 'HandleVisibility', 'off')
99
100 % YOU DOCUMENT tss IN THE SAME WAY AS tr AND Mp
101 % document tss
102 text(t(tssIndex),y(tssIndex), 'tss')
103 line([t(tssIndex);t(tssIndex)],[0,y(MpIndex)],...
104      'Color','k','LineWidth',0.5,'LineStyle',':', 'HandleVisibility', 'off')
105
106 title({'M_p, t_r, and t_s for a transfer function _{ECE 486}';date})
107 % Label the axes:
108 ylabel('t, time')
109 xlabel('response to step in reference')
110
111 % make the plot line thicker
112 hold on
113 plot(t,y,'-','LineWidth',2, 'HandleVisibility', 'off')
114 hold off

```