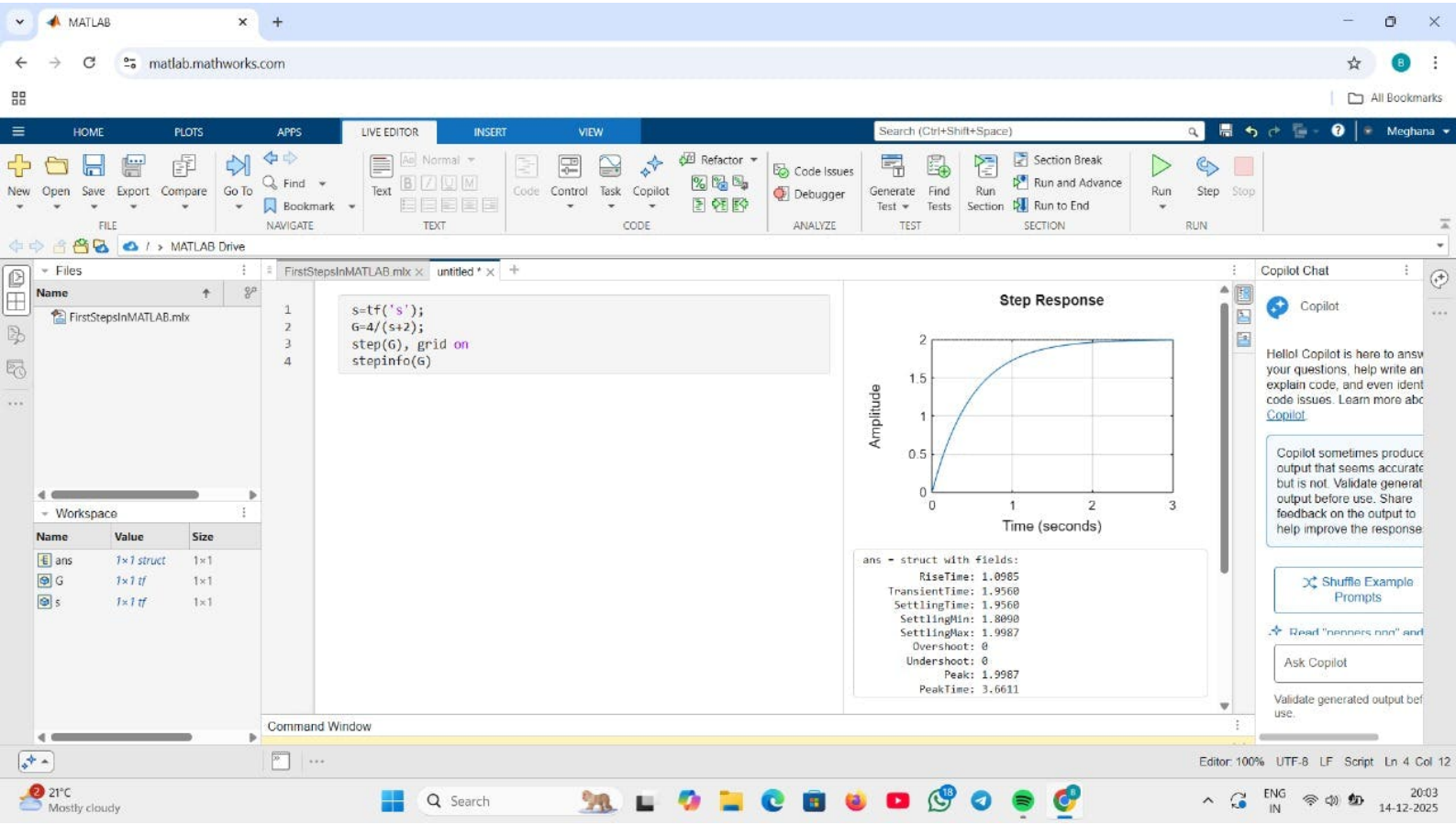
MATLAB
matlab.mathworks.com
HOME
PLOTS
APPS
LIVE EDITOR
INSERT
VIEW
Search (Ctrl+Shift+Space)
Meghana
New
Open
Save
Export
Compare
Go To
Find
Bookmark
Text
Normal
Code
Control
Task
Copilot
Refactor
Code Issues
Debugger
Generate Test
Find Tests
Run Section
Section Break
Run and Advance
Run to End
Run
Step
Stop
FILE
NAVIGATE
TEXT
CODE
ANALYZE
TEST
SECTION
RUN
MATLAB Drive
Files
Name
FirstStepsInMATLAB.mlx
untitled *
s=tf('s');
G=4/(s+2);
step(G), grid on
stepinfo(G)
Step Response
Amplitude
Time (seconds)
ans = struct with fields:
RiseTime: 1.0985
TransientTime: 1.9560
SettlingTime: 1.9560
SettlingMin: 1.8090
SettlingMax: 1.9987
Overshoot: 0
Undershoot: 0
Peak: 1.9987
PeakTime: 3.6611
Workspace
Name
Value
Size
ans
1×1 struct
1×1
G
1×1 tf
1×1
s
1×1 tf
1×1
Command Window
Copilot Chat
Copilot
Hello! Copilot is here to answ your questions, help write an explain code, and even ident code issues. Learn more abo Copilot.
Copilot sometimes produce output that seems accurate but is not. Validate generat output before use. Share feedback on the output to help improve the response.
Shuffle Example Prompts
Ask Copilot
Validate generated output bef use.
Editor: 100%
UTF-8
LF
Script
Ln 4 Col 12
21°C
Mostly cloudy
Search
ENG
IN
20:03
14-12-2025

Assignment - 01.

Q. 1. Understanding a first-order plant using step Response

$$G(s) = \frac{4}{s+2}$$

(2) (a) $\tau = \frac{1}{a} = \frac{1}{2} = 0.5$ sec.

(b) $t_r \approx 2.2\tau = 2.2(0.5) = 1.1$ sec.

(c) $t_s \approx 4\tau = 4(0.5) = 2$ sec.

(d) Final Value theorem

unit - step input $\rightarrow \frac{1}{s}$

$$y_{ss} = \lim_{s \to 0} s \cdot G(s) \cdot \frac{1}{s}$$

$$= \lim_{s \to 0} s \cdot \frac{4}{s+2} \cdot \frac{1}{s} = \frac{4}{2} = 2$$

(e) $e_{ss} = 1 - y_{ss} = 1 - 2 = -1$

{output is larger than input}

(3.) MATLAB final value = 2.

final value theorem = 2

$\rightarrow$ Both matches.

Q.2 System Type, step error, & final value theorem

$$G(s) = \frac{10}{s(s+5)}$$

① one pole at $s = 0$

$\Rightarrow$ Type - 1 system

② <u>open - loop system</u> :-

$$R(s) = \frac{1}{s}, \quad G(s) = \frac{10}{s(s+5)}$$

$$Y(s) = G(s) \cdot R(s)$$

error : $E(s) = R(s) - Y(s) = \frac{1}{s} - \frac{10}{s(s+5)} \cdot \frac{1}{s}$

$$e_{ss} = \lim_{s \to 0} s \cdot E(s)$$

$$= \lim_{s \to 0} \left(1 - \frac{10}{s(s+5)} \right) = \infty$$

$\Rightarrow$ infinite steady state error.

<u>Closed - loop system</u> :-

$$E(s) = \frac{R(s)}{1 + G(s)} = \frac{1/s}{1 + \frac{10}{s(s+5)}}$$

$$= \frac{1}{s} \cdot \frac{s(s+5)}{s(s+5) + 10}$$

$$e_{ss} = \lim_{s \to 0} s E(s)$$

$$= \lim_{s \to 0} \frac{s(s+5)}{s(s+5)+10} = 0$$

$\Rightarrow$ zero steady state error.

(3) Since $e_{ss} = 0$ for closed loop system, the step response should reach 1.

Q.3 Required specifications $\rightarrow$ Modify Transfer function.

$$t_s < 1.2 \text{ sec.}, \quad e_{ss} = 0.1$$

(1) • $t_{ss} \approx \frac{4}{a} < 1.2 \Rightarrow a > \frac{4}{1.2}$

$\Rightarrow a > 3.33$ (choosing $a = 4$)

• $e_{ss} = \frac{1}{1+K} = 0.1 \Rightarrow 10 = 1 + K$

$\Rightarrow K = 9$

(2) Modified plant:-

$$G_{new}(s) = \frac{9}{s+4}$$

(3) same shape as in Q.1.

• faster than Q1. (larger pole)

• higher final value

$$y_{ss} = \lim_{s \to 0} s \cdot \frac{9}{s+4} \cdot \frac{1}{s} = \frac{9}{4} = 2.25$$

Q.4 Designing a Simple Controller to Meet Specifications.

$$G(s) = \frac{3}{s+1}$$

$$C(s) = K(s+z)$$

$t_s < 2\ s$, $M_p < 10\%$, $y_{ss} = 0.8$

(1) • $z = 1$

• $e_{ss} = \frac{1}{1+K_p}$, $y_{ss} = 0.8$

$e_{ss} = 1 - 0.8 = 0.2$

$$0.2 = \frac{1}{1+K_p}$$

$\Rightarrow K_p = 4$

DC Gain of system:

$K_p = C(0)\,G(0)$

$K_p = K(z) \cdot 3$

$K = \frac{4}{3} = 1.33$ $\{z = 1\}$

•

$$M_p = e^{\left(\frac{-\xi\pi}{\sqrt{1-\xi^2}}\right)}$$

$M_p < 10$

$$\Rightarrow e^{\left(\frac{-\xi\pi}{\sqrt{1-\xi^2}}\right)} < 10$$

$$\ln 10 > \frac{-\xi\pi}{\sqrt{1-\xi^2}}$$

on solving,

$\xi \geq 0.6$

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(2) $$T(s) = \frac{C(s)\,G(s)}{1 + C(s)\,G(s)}$$

$$= \frac{1.33\,(s+1)\cdot\frac{3}{s+1}}{1 + 1.3\,(s+1)\cdot\frac{3}{s+1}}$$

$$= \frac{1.33\,(s+1)\cdot 3}{(s+1) + 1.33\,(s+1)\cdot 3}$$

(3)
- increase overshoot
- increase y_{ss} $\left\{ e_{ss} = \frac{1}{1+K_p} \right\}$
- yes

Q.5 :- Ramp Tracking and System Type.

$r(t) = t$ (unit ramp)

$R(s) = \frac{1}{s^2}$

(#) Plant Only (No controller)

$$G(s) = \frac{3}{s+1}$$

(1) No pole at $s=0$

→ Type-0 system

(2) for Type-0 system,

Ramp input → infinite error

$\Rightarrow e_{ss} = \infty$

③ Final value theorem.

$$E(s) = R(s) - Y(s)$$

$$Y(s) = G(s)\,R(s) = \frac{3}{s+1} \cdot \frac{1}{s^2}$$

$$E(s) = \frac{1}{s^2} - \frac{3}{(s+1)s^2}$$

$$e_{ss} = \lim_{s \to 0} s\,E(s)$$

$$= \lim_{s \to 0} s \cdot \left(\frac{1}{s^2} - \frac{3}{(s+1)s^2} \right)$$

$$= \infty$$

Ramp cannot be tracked by plant alone

<u>AFTER ADDING CONTROLLER</u>

$$C(s) = k(s+z)$$

$$T(s) = \frac{C(s)\,G(s)}{1 + C(s)\,G(s)}$$

① $C(s) \cdot G(s) = \dfrac{3k(s+z)}{s+1}$

$\Rightarrow$ Type-0 system

② Type-0 system

$$e_{ss}^{ramp} = \infty$$

③ $e_{ss}^{ramp} = \lim_{s \to 0} s\left(\frac{1}{s^2} - T(s) \cdot \frac{1}{s^2}\right)$

$e_{ss}^{ramp} = \infty$

④ zero does NOT help ramp tracking.