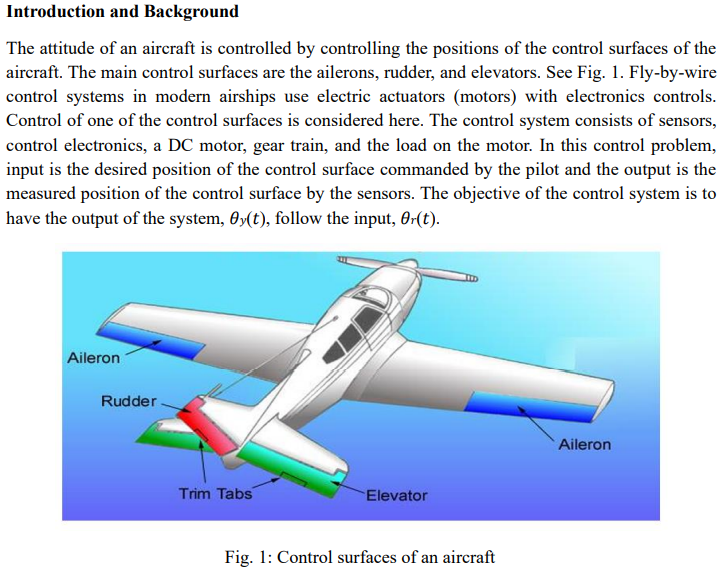
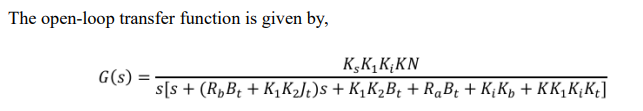
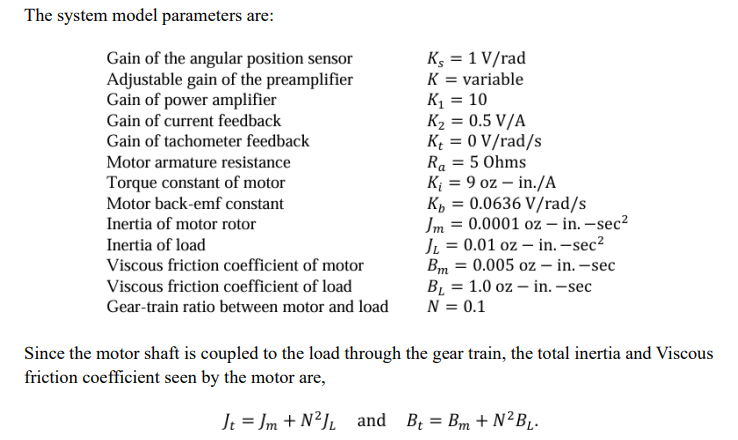
**BANDARA H.G.T.D.**

**2022/E/048**

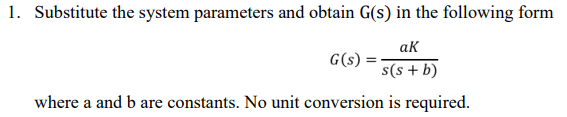
**SEMESTER 05**

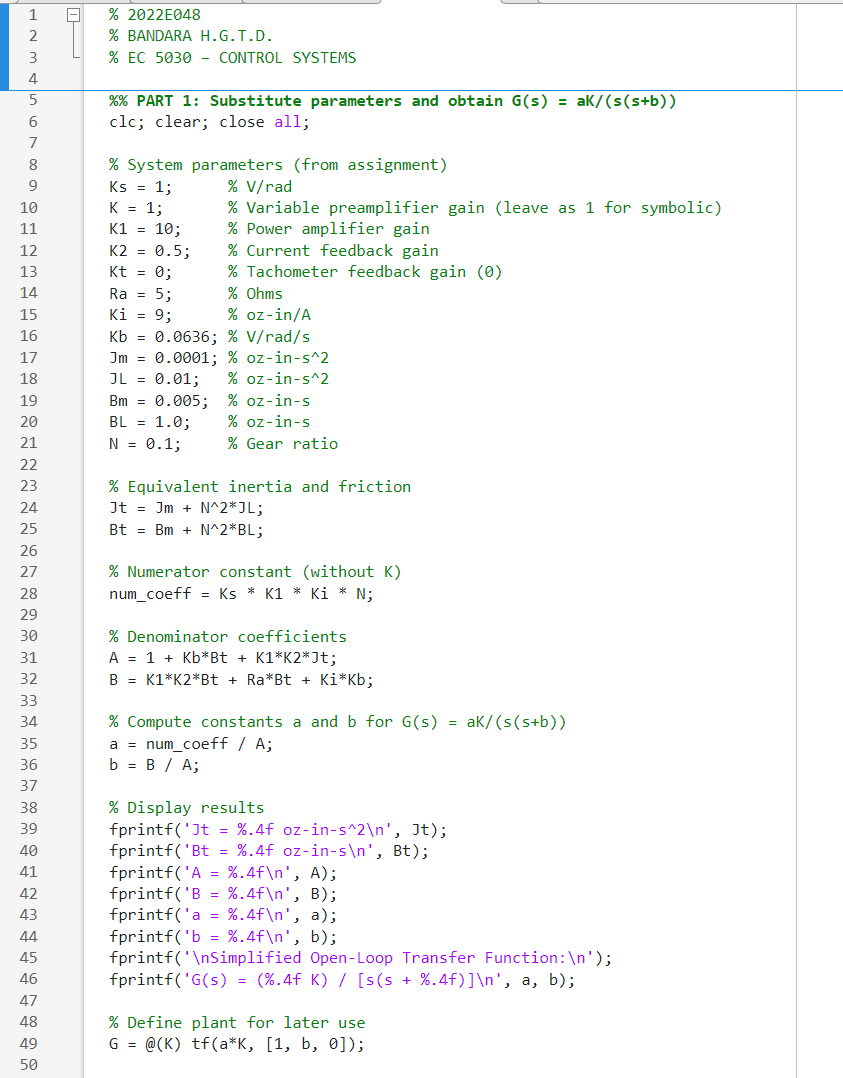
**2025/04/07**

**DESIGN AND COMPUTER SIMULATION OF A CLOSED – LOOP CONTROL SYSTEM OF ATTITUDE CONTROL OF AN AIRCRAFT**



**TASKS**



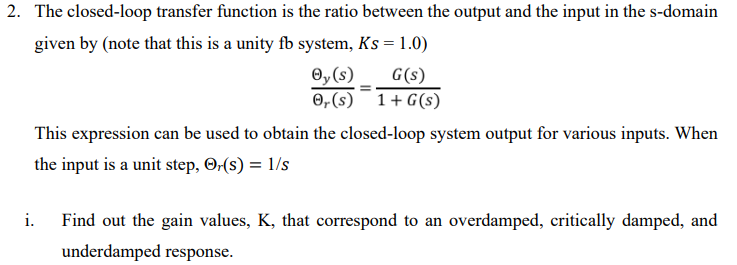


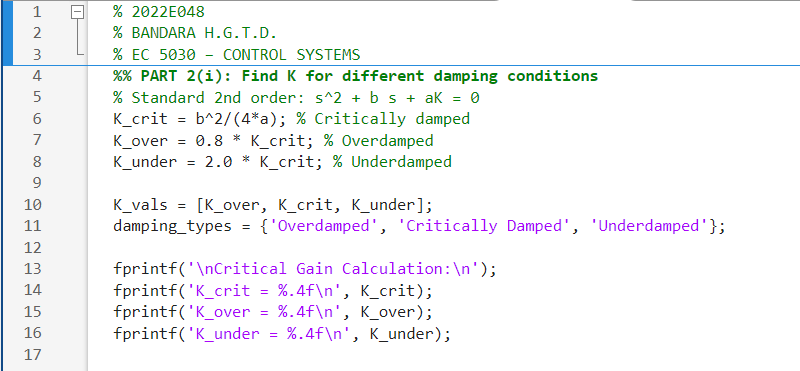
**FIGURE 01: MATLAB CODE FOR OBTAINE G(s)**

**A screenshot of a computer program

AI-generated content may be incorrect.FIGURE 02: OBTAINED MATLAB OUTPUT FOR G(S)**

**Then,**

**G(s) =**

****

**FIGURE 03: MATLAB CODE FOR FIND K FOR DIFFERENT DAMPING CONDITIONS**

**A number of numbers and symbols

AI-generated content may be incorrect.**

**FIGURE 04: OUTPUT**

* K =0.0116 → Overdamped
* K = 0.0145 → Critically damped
* K = 0.0289 → Underdamped

**Characteristic Equation**

S2+0.7210S+8.9824K=0

**Damping and Gain Selection**

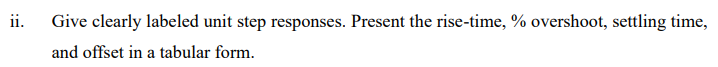
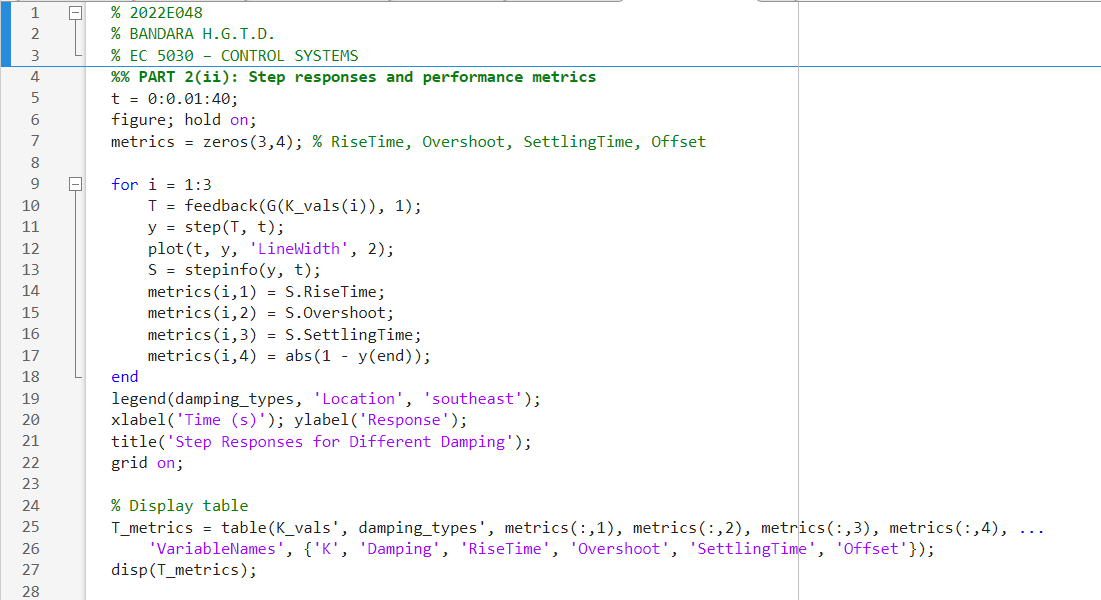
The standard second-order form is:

*S*2+2*ζωnS*+*ω2n*=0

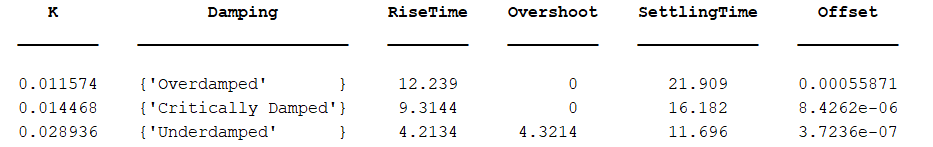
2*ζωn* =0.7210, *ω2n* =8.9824*K*

A screenshot of a computer

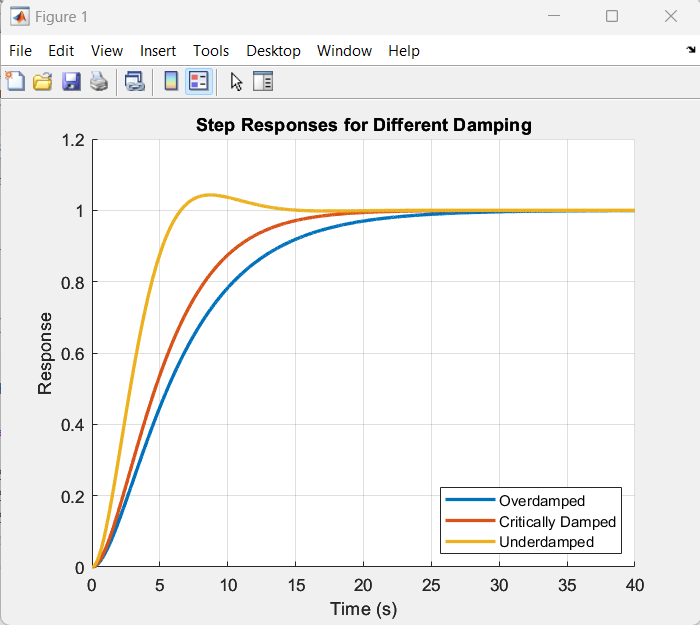
AI-generated content may be incorrect.**Critical Damping Gain:**



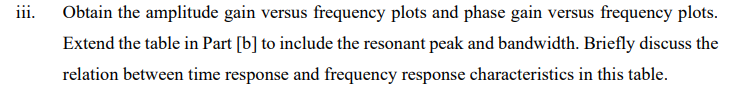
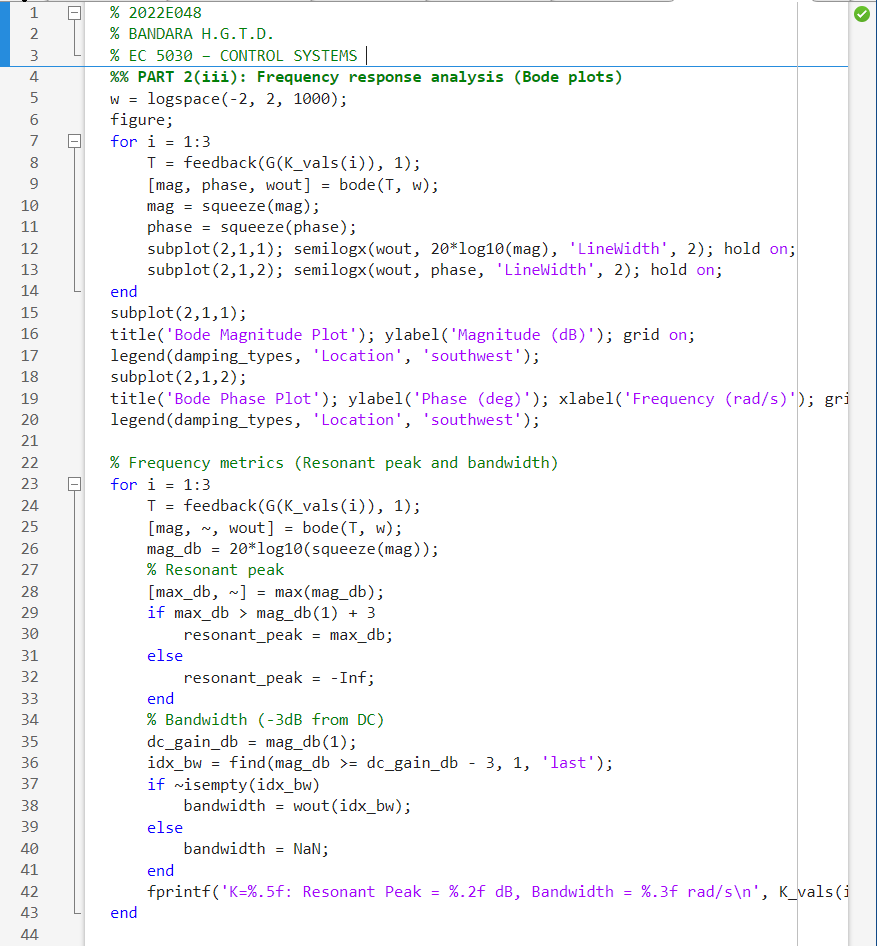
**FIGURE 04: MATLAB CODE FOR PART 2(ii)**



**FIGURE 05: OUTPUT FOR PART 2(ii)**



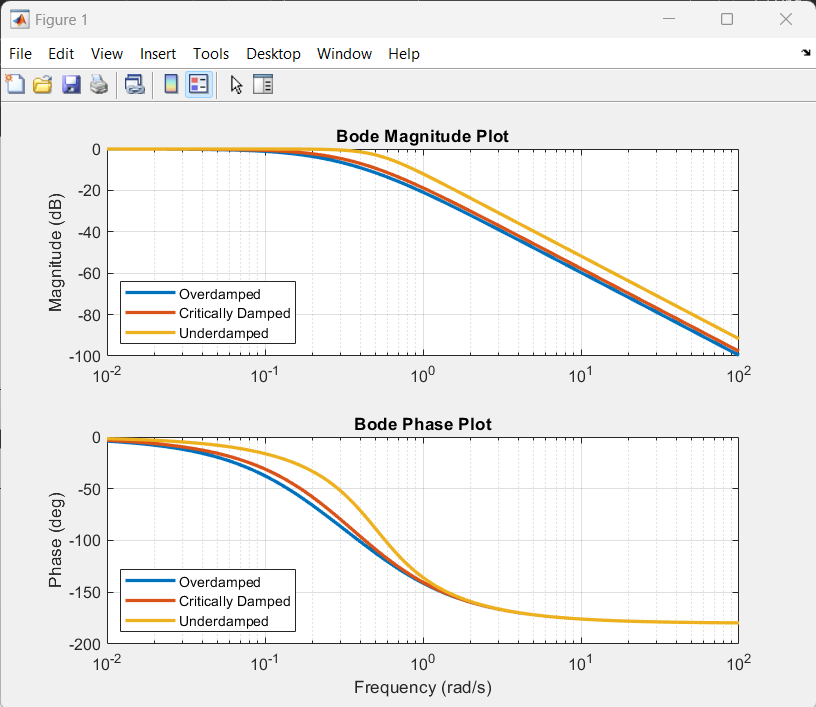
**FIGURE 06: STEP RESPONSES FOR DIFFERENT DAMPING**

**FIGURE 07: MATLAB CODE FOR PART 2(iii)**

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AI-generated content may be incorrect.

**FIGURE 08: VALUE OF RESONANT PEAK AND BANDWIDTH**



**FIGURE 09: AMPLITUDE GAIN VERSUS FREQUENCY PLOTS AND PHASE GAIN VERSUS FREQUENCY PLOTS**

**OBSERVATIONS:**

* Higher bandwidth correlates with faster rise time.
* Resonant peak magnitude correlates with overshoot.

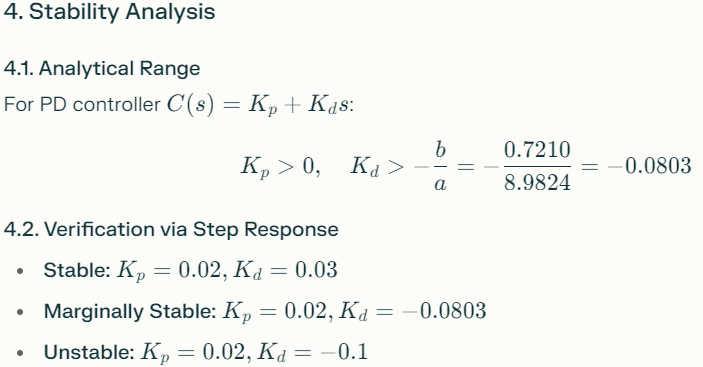


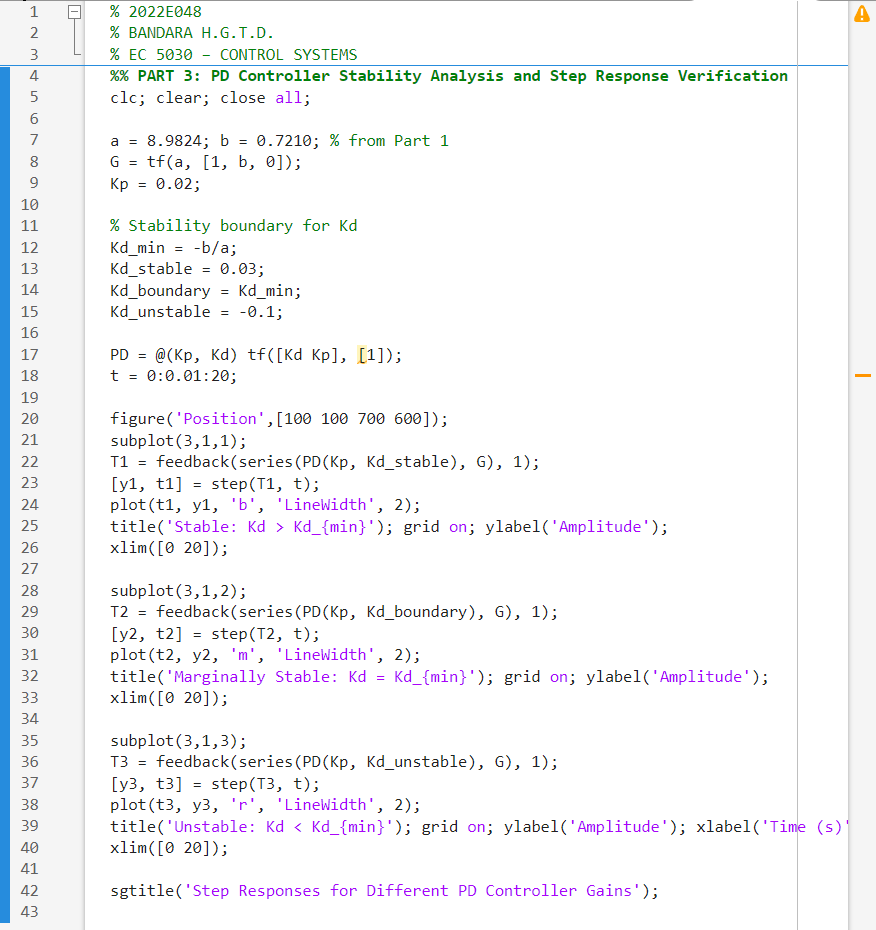
**Recommended Controller:** **PD Controller**

**Justification:**

* The system is Type 1 (integrator present), so it already has zero steady-state error for step inputs.
* Proportional control alone causes excessive overshoot.
* Derivative action (PD) reduces overshoot and improves damping, which is crucial for aircraft safety.
* PI control is not needed, as steady-state error is already negligible.

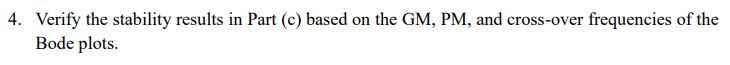
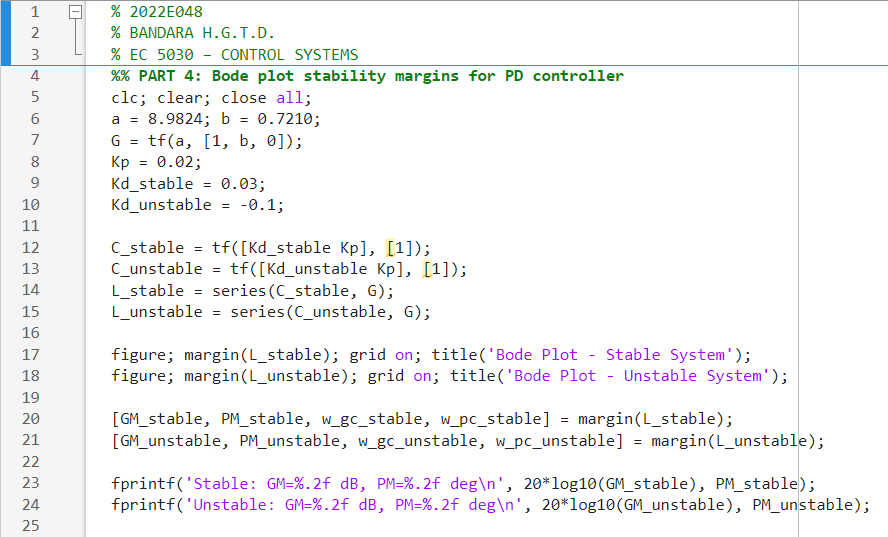




**FIGURE 10:** **MATLAB CODE FOR THE PART 3**



**FIGURE 11: STEP RESPONSES FOR DIFFERENT PD CONTROLLER GAINS**



**FIGURE 12: MATLAB CODE FOR THE PART 4**

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**FIGURE 13: OUTPUT VALUES**

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AI-generated content may be incorrect.

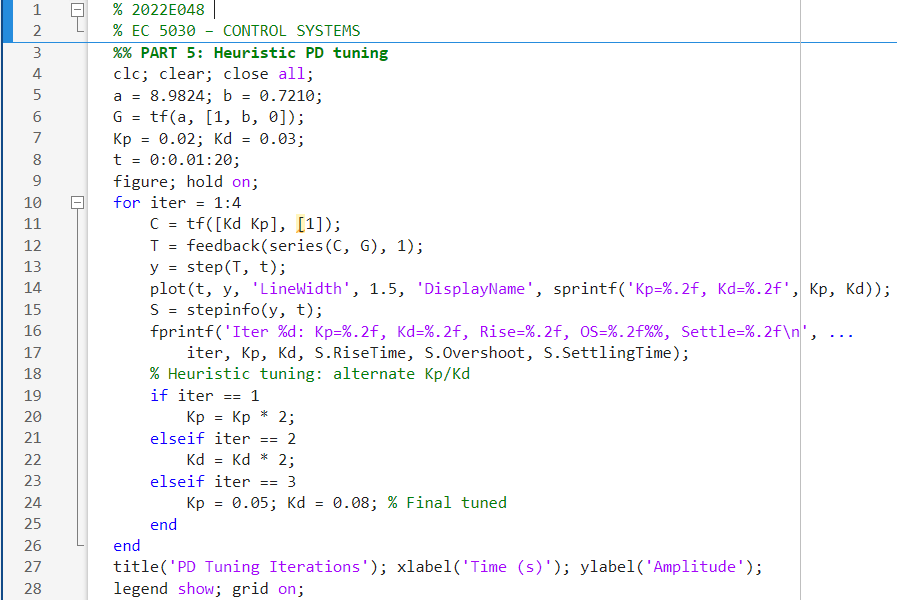
A screenshot of a computer

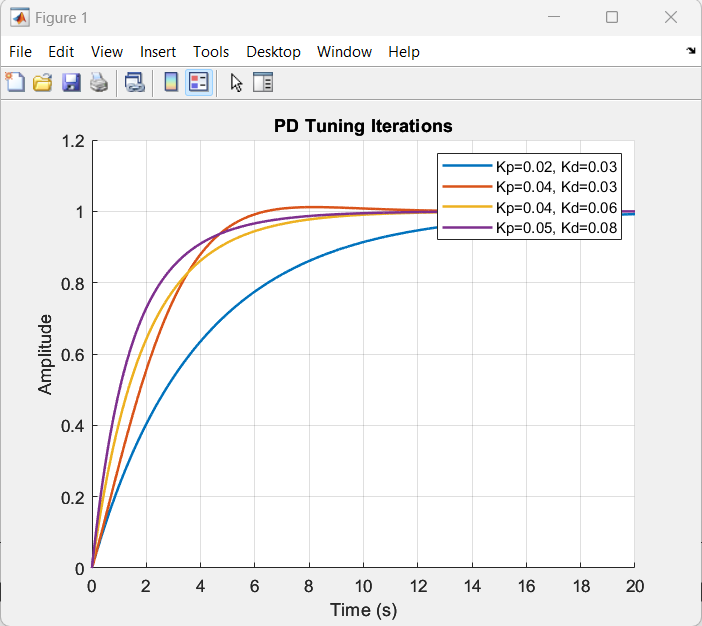
AI-generated content may be incorrect.

A screenshot of a computer

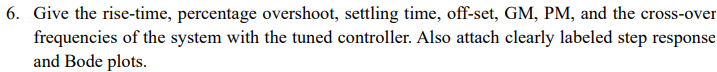
AI-generated content may be incorrect.**FIGURE 14: BODE PLOT FOR STABLE SYSTEM**

**FIGURE 15: BODE PLOT FOR UNSTABLE SYSTEM**

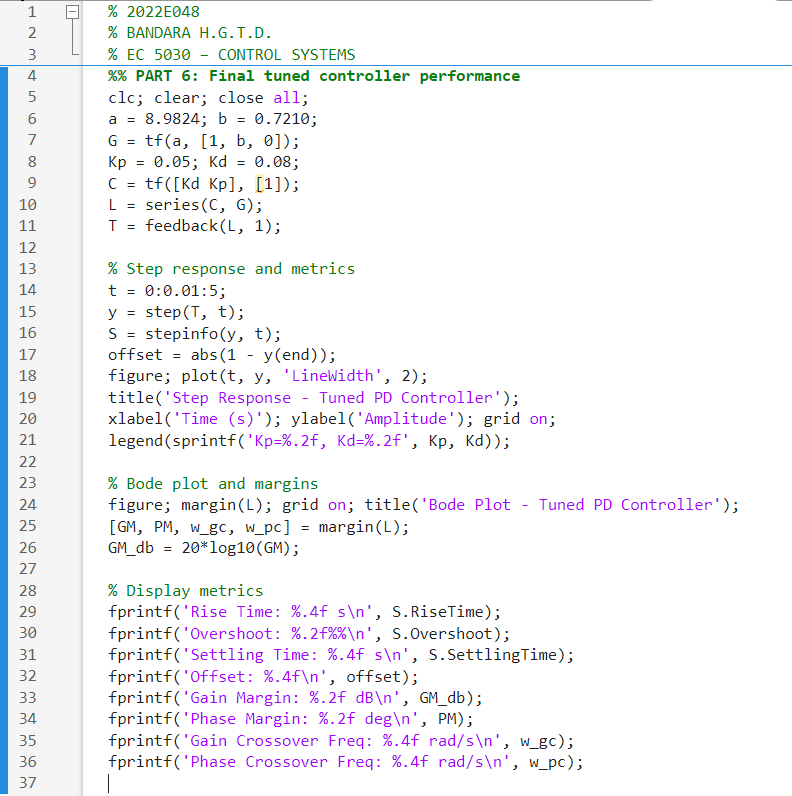
5) Heuristically tune the controller recommended in Part (2) [d] to obtain the optimal closed-loop control performance. Clearly show your approach to tuning (supported by suitable time or frequency domain plots and brief discussion of the intermediate results).

**FIGURE 16: BODE PLOT FOR UNSTABLE SYSTEM**

**FIGURE 17: PD TUNING ITERATIONS**

A screenshot of a computer

AI-generated content may be incorrect.**FIGURE 18: PD TUNING ITERATIONS AND THE OUTPUT VALUES**



**FIGURE 19: MATLAB CODE FOR PART 6**

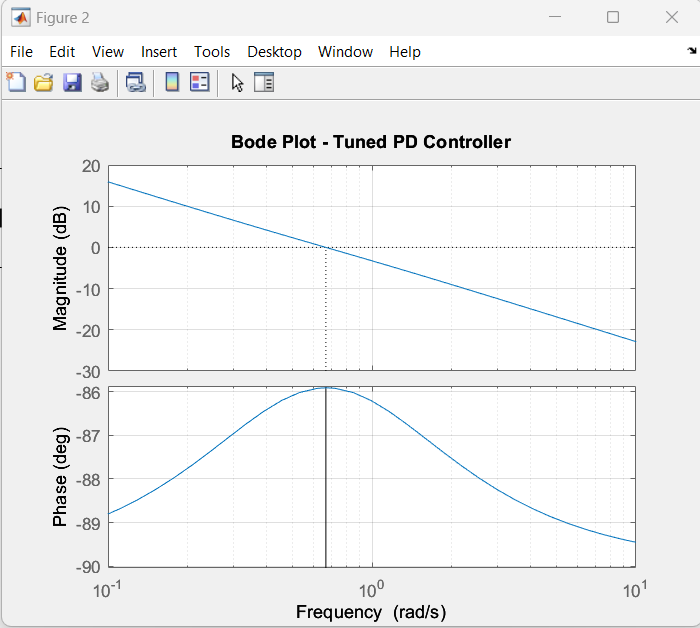
A screenshot of a computer

AI-generated content may be incorrect.

**A screen shot of a graph

AI-generated content may be incorrect.FIGURE 20: FINAL PERFORMANCES OF THE TUNED CONTROLLER**

**FIGURE 21: STEP RESPONSE OF TUNED PD CONTROLLER**

****

**FIGURE 22: BODE PLOT OF TUNED PD CONTROLLER**