STUDENT LAB SAFETY, HIRARC, DATASHEET VERIFICATION CHECKLIST, AND BRIEF REPORT SUBMISSION

EXPERIMENT KW7: CONTROL SYSTEM SIMULATION USING MATLAB AND SIMULINK (OPEN-ENDED)

STUDENT NAME : _____
MATRIC NO. : _____
GROUP : _____
DATE : _____

A. Equipment and System Verification Checklist

Item	Verification Requirement	✓
MATLAB / Simulink	Software opens correctly and Control System Toolbox is licensed/functional.	□
Model Units / Variables	Script vectors and numerator/denominator coefficients are verified prior to execution.	□
System Parameters	Block parameters, plant transfer function coefficients, and gain values are specified correctly.	□
Simulink Routing	Feedback loops, summing junction signs ($\mid + -\mid$), and scope signals are connected properly.	□
Solver Settings	Fixed-step/variable-step solver configurations and stop times are set to 30 seconds.	□
File Management	Script files (.m) and model files (.slx) are saved using an identifiable structure.	□

B. HIRARC Checklist (OSH-Based Risk Assessment)

Hazard / Unsafe Condition	Potential Consequence	Control Measure	✓
Incorrect TF coefficient ordering	Severe model error / invalid simulation	Double-check powers of s in vector order before running scripts.	□
Unstable feedback gain selection	Rapid signal divergence on scope plot	Monitor output bounds; stop simulation if signals grow uncontrollably.	□
Unsaved workspace variables	Data loss between MATLAB script runs	Export signal arrays using To Workspace or save workspace .mat files.	□
Incorrect solver step-size	Numerical integration errors or solver crash	Adjust solver algorithm (e.g., ode45) or step-size limits in Simulink.	□
Extended computer workstation use	Physical discomfort / eye strain	Maintain ergonomically correct seating posture and take short visual breaks.	□

C. Engineering Practice Verification

Requirement	✓
Transfer function and ZPK model representations are generated and recorded.	□
Pole-zero locations and complex s-plane grids (sgrid) are generated.	□
Unit impulse and unit step time responses are evaluated across specified time intervals.	□
Closed-loop Simulink system is constructed and tested across stable, oscillatory, and unstable gains.	□

PID parameters are tuned and evaluated against rise time, settling time, overshoot, and steady-state error.	☐

D. Student Declaration

I confirm that I have completed the above verification and HIRARC checks, verified the MATLAB/Simulink workspace and model settings, and will report any software, workstation, or laboratory issue to the demonstrator/technician.

Student Signature : _____

Date : _____

E. Experiment Data Results and Discussion

In Lab Task (During Lab)

Task 2: Test 1 — Control System in MATLAB Data Sheet

Procedure / Question	MATLAB Command Used	Output / Observation / Analysis	Key System Parameter Value / Description	MATLAB Command Window Output
Transfer Function (TF) Creation				
Zero-Pole-Gain (ZPK) Creation				
Complex ZPK Creation				
Pole-Zero Map of $\boldsymbol{H(s)}$				
Impulse Response of $\boldsymbol{H(s)}$				
Step Response of $\boldsymbol{H(s)}$				
Impulse Response with Time Interval				
Step Response with Time Interval				

Task 3: Test 2 — Control System in Simulink Data Sheet

Task / Question	Gain Value (K) / PID Parameters	System Response Observation	Analysis based on K
Initial Simulation ($\boldsymbol{K = 1}$)			
Q4: Stable Response			
Q5: Oscillatory Response			
Q6: Unstable Response			
Q7: Best PID Performance			

Task 4: In-Lab Analytical & Open-Ended Questions

Q1. Pole-Zero Map Analysis

Consider the transfer function $\boldsymbol{G(s) = \frac{4.5s^2+1}{s^3+3s^2+3s+7}}$. Write the MATLAB code to plot its pole-zero map, list the extracted pole and zero values, and describe the system stability.

Answer / Code:

Q2(c). Time Response Comparison

Question / Task	Key Concept to Discuss	Analysis / Explanation Requirement
Q2(c) in Test 1	Impulse vs. Step Response	Explain why the results for 2(a) and 2(b) are not the same, stating the mathematical operation that relates the unit impulse response $h(t)$ to the unit step response $y_{\text{step}}(t)$.

Answer:

Q3. Effect of Zero Location

Question / Task	Key Concept to Discuss	Analysis / Explanation Requirement
Q3 in Test 1	Effect of Zero Location (z)	Analyze the change in transient response (overshoot and peak time) for $X(s)/R(s) = \frac{15/z(s+z)}{s^2+3s+15}$ as z varies ($z = 3,6,9,12$) for impulse and step inputs. Explain how a LHP zero influences dynamic response.

Answer:

Q4–Q6. Stability & Pole Movement Analysis

Question / Task	Key Concept to Discuss	Analysis / Explanation Requirement
Q4, Q5, Q6 in Test 2	Root Locus & Stability	For $1 + KG(s) = 0$, show how dominant pole movement across the imaginary axis (LHP → $j\omega$-axis → RHP) dictates the transition from stable, to oscillatory, to unstable behavior as K increases.

Answer:

Q7. PID Controller Tuning & Performance Analysis

Question / Task	Key Concept to Discuss	Analysis / Explanation Requirement
Q7 in Test 2	PID Control Theory	Explain the mechanism by which Proportional (P), Integral (I), and Derivative (D) terms contribute to optimal performance. Specify how the I term eliminates steady-state error and how D improves transient damping.

Answer:

DISCUSSION:

CONCLUSION:

LAB LECTURER **INSTRUCTOR**

SIGNATURE : _____ **SIGNATURE** : _____

DATE : _____ **DATE** : _____