SCHOOL OF ARCHITECTURE, COMPUTING & ENGINEERING

University of East London
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Submission instructions

- Cover sheet to be attached to the front of the assignment when submitted
- Question paper to be attached to assignment when submitted
- All pages to be numbered sequentially
- All work has to be presented in a ready to submit state upon arrival at the Hub. Assignment cover sheets or stationery will **NOT** be provided by the Hub staff.

Module code	EG5027		
Module title	Dynamics and Control		
Module leader	Dr Kalok Lee		
Assignment tutor	Lucian Nita		
Assignment title	Control Systems Coursework		
Assignment number	2		
Weighting	25%		
Hand-out date	13 March 2025		
Submission date	29 April 2025		
Learning outcomes assessed by this assignment	3, 4, 5		
Turnitin submission requirement	Yes	**Turnitin Grade Mark feedback used?**	No
UEL Plus Grade Book submission used?	No	**UEL Plus Grade Book feedback used?**	No
Other electronic system used?	No	**Are submissions / feedback totally electronic?**	Yes
Additional information			

Form of assessment:

☒ Individual work ☐ Group work

Number of assignment copies required:

☐ 1 ☐ 2 ☐ Other

Assignment to be presented in the following format:

☒ On-line submission
☐ Stapled once in the top left-hand corner
☐ Glue bound
☐ Spiral bound
☐ Placed in a A4 ring bound folder (not lever arch)

Note: To students submitting work on A3/A2 boards, work has to be contained in suitable protective case to ensure any damage to work is avoided.

Soft copy:

☐ CD (to be attached to the work in an envelope or purpose made wallet adhered to the rear)
☐ USB (to be attached to the work in an envelope or purpose made wallet adhered to the rear)
☐ Soft copy not required

Note to all students

Assignment cover sheets can be downloaded from logging into UEL Direct via the following pathway.

UEL Direct → My Record → My Programme → Assessment log dates with bar-coded front sheet

Module Code	EG5027
Module Title	Dynamics and Control
Assignment Title	Dynamics Systems Coursework
Assignment Value	25% of the module total
Lecturer(s)	Lucian Nita
Submission Deadlines	16.00 GMT 29 April 2025

Control Systems Coursework: Controller design and analysis

1 Assignment Brief

Pole placement and MATLAB basics

Most real-world dynamical systems are extremely complex and thus very difficult to model and simulate. In practice, it is common to only capture the most relevant dynamics and approximate the system using a first order, second order, or third order model. In this coursework, we will consider a system represented by the following open-loop transfer function:

$$H(s) = \frac{4}{s^3 + 5s^2 + 9s + 5} \tag{1}$$

Task 1: Compute the open loop poles for $H(s)$. Consider a P controller with gain K. Plot the block diagram of the closed loop system and derive the closed loop transfer function. Compute the poles of the closed loop system as a function of gain K: $s_1(K)$, $s_2(K)$, $s_3(K)$.

Task 2: Write a MATLAB function to compute the open loop poles for an arbitrary system with transfer function provided as input. The function should also construct the closed loop interconnection with a PID controller and compute the closed loop poles. The function should take as inputs: the transfer function of the open loop system, the proportional P, integral I and derivative D gains, and return two vectors, first containing open loop poles and second containing closed loop poles. You can use the signature

```
function [ol_poles,cl_poles] = pole_calculator(sys,P,I,D)
```

Provide the MATLAB code along with a root locus plot for the system $H(s)$.

Numerical experimentation and controller design using MATLAB

In the next task you will design PID controller based on numerical experimentation. You will be expected to quantify the performance of your controller and optimize its design.

Task 3: Develop a PID controller in MATLAB for the system $H(s)$ subject to the following constraints

- Peak overshoot should be below 10%
- The rise time should be below 1 second
- The 2% settling time should be below 5 seconds

Write a function that takes as inputs P, I and D values and returns: the root mean squared error err between the system output and the unit step reference for the time interval $[0, 20]$ seconds and a granularity of $dt = 0.01$, overshoot M, rise time t_r, settling time t_s, gain margin gm and phase margin pm. You can use the signature

```
function [err,M,t_r,t_s,gm,pm] = cl_sys(P,I,D)
```

Provide your MATLAB code along with a table containing the numerical experiments of attempted P, I and D values and obtained outputs. Apart from satisfying the above conditions on step response characteristics, explain in no more than two phrases what are the general principles for good closed loop design. How can you quantify the performance of your controller and further improve your design?

2 Assignment Submission Requirements

Your formal report should be submitted as a PDF file of no more than **four** A4 pages. Title page is **not** required, but should you decide to include a title page, that will be counted towards the page limit and only the first four pages will be assessed. Pages of the file should be numbered consecutively and shown on the centre footer of each page. Your student number must be clearly shown on the right header of all pages.

The font size used must be at least 11 points in the main text and 10 points in figures and tables. The page layout should be single-column and margins should not be less than 20 mm. Both clarity and efficiency are important in technical writing, and both will be considered when marking your report. A short report that is clear and addresses the main objectives stated in the brief will receive a higher mark than a long report that covers the same content, but includes unnecessary information. Equations prepared using technical typesetting software, such as LaTeXor MathType, are preferred, but if you are not able to do so, high-quality scanned clear and legible hand-prepared equations are acceptable.

The filename of the report should contain the module code, your student ID and assignment identifier (CW2) in the following notation: `EG5027_u1234567_CW2.pdf` (**Note:** replace `u1234567` with your own student ID and remember to use lower case `u`).

The report should be submitted via the appropriate EG5027 Moodle assignment submission portal by 16:00 GMT 29 April 2025.

3 Assignment Mark Distribution

Marking scheme of formal report	
Assessed Element	Value
Quality of the report	10%
Task 1	20%
Task 2	30%
Task 3	40%