

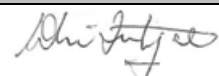
ASSIGNMENT INTERNAL VERIFICATION FORM (2017-2018)

ASSIGNMENT TITLE:	Analysis, Simulation and Evaluation of Control Systems	LEVEL:	5
MODULE :	PSDE5009 – Electrical Principles, Methods and Simulation	ASSIGNMENT NO (x of y):	2 of 2
PROGRAMME:	HNC Electrical and Electronic Engineering	ASSIGNMENT AUTHOR :	R. Davies

VERSION:	DATE SUBMITTED FOR VERIFICATION :	INTERNAL VERIFIER COMMENTS (Approval or detail of amendments required):	DATE
1.	28-02-18	Conforms to the assessment pattern described in the module syllabus Tests the module learning outcomes appropriately	28/02/18
2.			

INTERNAL VERIFIER PLEASE TICK TO INDICATE THAT THE COURSEWORK:

✓	Conforms to the assessment pattern described in the module syllabus
✓	Tests the module learning outcome(s) appropriately

SIGNATURES OF FINAL APPROVAL:	SIGNATURE	DATE
INTERNAL VERIFIER: I confirm that this version of the assignment specification is ready to be sent to the external examiner		28/02/18
ASSIGNMENT AUTHOR: I confirm that internal verifier and external examiner approval have been received and that this version of the assignment specification will be distributed to students		

LEVEL/ LEFEL **5**

SEMESTER **2**

MODULE CODE/ COD Y MODIWL: **PSDE5009**
ELECTRICAL PRINCIPLES, METHODS AND SIMULATION

ASSESSMENT TYPE/ MATH O ASESU: **ASSIGNMENT**

ASSESSMENT/COMPONENT/ ASESAD/CYDRAN: **2** OF 2

COMPONENT WEIGHTING/ PWYSAU'R CYDRAN: **50%**

WORD COUNT (or WORD COUNT EQUIVALENT)/ NIFER Y GEIRIAU:
2500 and 3000 WORDS/O EIRIAU

MODULE TUTOR / TIWTOR Y MODIWL: ROBERT DAVIES

SUBMISSION DETAILS/ MANYLION CYFLWYNO:

- Make sure that Your Name , Your Student P Number, Your Module Title, Assignment Title and Your Module Lecturer's Name are clearly shown on the front page of your assignment
- All assignments must be submitted electronically to Turnitin unless indicated by the module lecturer here:
- If lecturer additionally requires you to upload coding separately to Moodle it will be indicated here:**NO**
- If a paper submission is required, then it will be indicated here:**NO**
you will then be required to submit the assignment parts in a suitable report folder–
not in poly-pockets - to the module tutor.
For paper submissions only this form (ALL PAGES) MUST be printed out, signed, attached to the front of your assignment and submitted to the module tutor separately from your electronic assignment submission. Paper submission assignments will not be accepted without this form as it is a requirement that you sign the disclosure regarding the referencing convention.
- DO NOT put this form into Turnitin or it will match many similarities with other students' submissions.

ASSIGNMENT SPECIFICATION

Student name:		Student P number:	
Programme:	HNC Electrical and Electronic Engineering		
Lecturer:	Robert Davies	Internal Verifier:	Bill McIntyre
Assignment Title:	Analysis, Simulation and Evaluation of Control Systems		
Hand Out Date:		Submission deadline:	

Referencing:	In the main body of your submission you must give credit to authors on whose research your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have read or quoted in order to complete this assignment (e.g. for books: surname of author and initials, year of publication, <u>title of book</u> , edition, publisher: place of publication).		
Disclosure:	I declare that this assignment is all my own work and that I have acknowledged all materials used from the published or unpublished works of other people. All references have been duly cited.		
Student's Signature:	<i>Hardcopy assignments will not be accepted without a signature here</i>	Date:	

Late submission will result in a late penalty mark, as follows:

Up to one week late, maximum mark of 40% for first attempts. No late submission for resit work.
(Academic Quality Handbook 2016/17 7.5 (5))

Only the Extenuating Circumstances Committee may grant an extension.

**Learning Outcomes tested
(from module syllabus)**

1. Analyse and evaluate electrical circuits, electronic systems and control systems*

2. Simulate standard electrical circuits, electronic systems and control systems*

** Partially covered for control systems only. Electrical circuits and electronic systems were covered in assignment 1.*

TASK DESCRIPTION

Aims and Objectives

The aims of this assignment are to develop your knowledge and analytical skills in the analysis and evaluation of control systems through simulation of developed models.

The objectives of the assignment are to show your ability to:

- Convert mathematical information regarding circuits into a format suitable to be solved using Matlab.
- Develop mathematical models using transfer functions and then use Matlab to predict performance.

The assignment focuses on the simulation of control systems using mathematical models with Simulink for first and second order systems. A model of a DC motor is developed and its performance analysed with respect to theory. Types of controller including P, PI and PID are analysed and tested with the motor model and tuned for best performance.

You will be expected to show all your workings out for the mathematical models and predictions of performance which must be included in your report in handwritten or typed format to demonstrate your understanding and must be included in the electronic submissions (Turnit-in).

Specific learning outcomes for IEng have been included in brackets in some tasks with an explanation of the assessment mapping given on the back page.

Assignment Tasks

Task 1 – First Order System

Analyse the system model shown in figure 1, produce the overall transfer function, plot the argand diagram and comment on its stability. Determine the minimum gain required in the feedback and use a root locus plot in Matlab to confirm it. Build the model using Simulink and measure its response to a step input with 3 different values of feedback gain. Present all your mathematical workings (*SM1i*), add annotations to your graphical results and summarise your results in a table and compare with theory.

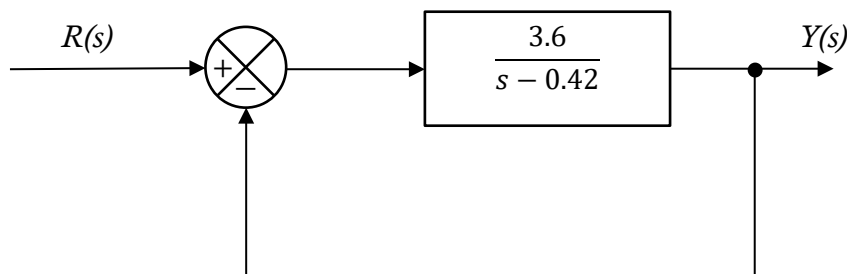


Figure 1

Task 2 – DC Motor Model

A DC permanent magnet motor has the following parameters:

- Armature resistance = 7.8 Ohms
 - Armature inductance = 0.05H
 - Rotor inertia = 0.000214 Kg m²
 - Friction coefficient = 15.519 x 10⁻⁶ Nm/rad/s
 - Motor voltage constant = 0.0983 V/rad/s
 - Motor torque constant = 0.09 Nm/A
 - Maximum armature voltage = 40V
- (a) Develop a mathematical model of the motor and its load, produce the transfer function with the disturbance initially set to zero. (SM1i)
- (b) Deduce the damping factor, stall torque, no-load-speed and the loaded speed with a disturbance of 0.025Nm. (SM1i)
- (c) Plot the poles on an argand diagram and give conclusions about stability. (SM1i)
- (d) Build a model of this motor system using Matlab Simulink.
- (e) Analyse the speed and torque responses of the motor over 20 seconds to an armature voltage step input of 24Vdc with the disturbance set to zero and thus measure the no-load-speed and torque of the motor.
- (f) Analyse the speed and torque responses of the motor over 20 seconds to an armature voltage-step-input of 24Vdc with the disturbance of 0.025Nm after 10 seconds and thus find the speed and current. Compare the loaded speed with the theoretical prediction.
- (g) Apply the theoretical stall torque after 10 seconds and check the result.
- (h) Summarise all your results in a table, analyse and compare with predicted values.

Task 3 – Proportional Speed Control System

- (a) Convert the motor model into a subsystem for simplicity. Add an outer loop to include a proportional controller with a step speed setpoint of 100 rad/s and speed feedback with a disturbance of 0.025Nm after 10 seconds. Use the standard PID block (set up for P only) and ensure the armature voltage is limited to 40Vdc. Run the auto tune feature and obtain the optimum value for the constant K_p.
- (b) Replicate the control system twice and feed the speed output signals into a 3 input scope. Manually adjust the values of K_p in the two new controllers above and below the auto tuned value. Run the simulation and measure the steady state error, rise time, overshoot (if any) for all three responses.
- (c) Discuss the effect of increasing or decreasing K_p.
- (d) Summarise all your results in a table, analyse and compare with theory.

Task 4 – Proportional-Integral Speed Control System

Save your Matlab file under a new name and convert each controller to PI. Auto tune the first and use the same value of K_p in all three systems. Then change the value of K_i in the other two controllers to demonstrate the effect of tuning. Measure the rise time, overshoot percentage, the settling time and the steady state error. Summarise all your results in a table, analyse and make comparisons. What can you now say about the effect of adding integral control and its behaviour when tuned.

Task 5 – Proportional-Integral-Derivative Speed Control System

Save your Matlab file under a new name and convert each controller to PID. Auto tune the first and use the same value of K_p and K_i in all three systems. Then change the value of K_d in the other two to demonstrate the effect of tuning. Measure the rise time, overshoot percentage, the settling time and the steady state error. Summarise all your results in a table, analyse and make comparisons. What can you now say about the effect of adding derivative control and its behaviour when tuned.

Task 6 – Controller Comparisons

Save your Matlab file under a new name and make one system P control, another PI control and the third can remain a PID controller. Plot the response of the three types of controller on the same scope and demonstrate the effects of controller improvement from P to PI to PID.

Task 7 – Conclusions and Recommendations

Provide some overall conclusions from all your results. What have you learnt about first and second order control systems. What can you now say about the effect of adding feedback to an unstable system? What about dc motor modelling and P, PI, PID controllers? Make some recommendations about what you would like to do to further your knowledge in this area. Be specific! (EA3i).

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

Requirements

You are required to present a printed formal report (and an electronically submitted copy through Turnitin) containing detailed observational notes of your work. This report must be between 2500 and 3000 words and should be laid out in the following sections preceded by a title page and a table of contents: -

1. **First Order Control System** (*task 1*)
2. **DC Motor Model Analysis** (*task 2*)
3. **Types of Motor Speed Controller** (*tasks 3, 4, 5 and 6*)
4. **Conclusions and Recommendations** (*task 7*)
5. **Appendices** (*handwritten mathematical model working if not typed up*).

Your pages should be numbered and your figures must also be numbered and listed.

You are expected to present a detailed critical analysis of all your observations and designs. Your design and analysis skills need to be evident in the written work.

Where workings have been handwritten, the final formulae must be included in the main report and references must be made to the appendix which could be scanned in, saved as a "pdf" file and appended to a "pdf" version of your report making 1 document to be submitted electronically through Turnitin.

You will be assessed against the three of the following five common assessment criteria. Note that sections of your report have been identified as places where the marks will be awarded.

1 Research Informed Literature

Not assessed in this assignment.

2 Knowledge and Understanding of subject (30%)

This will be assessed by your explanations of the theory associated with each of the systems which will include the mathematical development (handwritten or typed up) of the models inputted into Simulink where applicable. (Sections 1, 2 and 3).

3 Analysis (50%)

This will be assessed by the quality and analysis of your testing and presentation of all results obtained, your conclusions and recommendations. (Sections 1, 2, 3 and 4)

4 Practical Application and Deployment (10%)

This will be assessed by your use of Matlab and Simulink and by the presentation quality of your results. (Sections 1, 2 and 3)

5 Skills for Professional Practice (10%)

This will be assessed by the written and presentational quality of your report including page numbering, figure quality, figure numbering and listing, writing style, punctuation, grammar and spelling. (All Sections)

FdSc & HN COMMON ASSESSMENT AND MARKING CRITERIA

Assessment Criteria	OUTRIGHT FAIL	UNSATISFACTORY	SATISFACTORY	GOOD	VERY GOOD	EXCELLENT	EXCEPTIONAL
	REFER (equivalent to 0-29%)	REFER (equivalent to 30-39%*)	PASS (equivalent to 40-49%)	PASS (equivalent to 50-59%)	MERIT (equivalent to 60-69%)	DISTINCTION (equivalent to 70-79%)	DISTINCTION (equivalent to 80-100%)
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	Little or no evidence of reading. Views and findings unsupported and non-authoritative. Referencing conventions largely ignored.	Poor evidence of reading and/or of reliance on inappropriate sources, and/or indiscriminate use of sources. Referencing conventions used inconsistently.	References to a limited range of mostly relevant sources. Some omissions and minor errors. Referencing conventions evident though not always applied consistently.	Inclusion of a range of research-informed literature, including sources retrieved independently. Referencing conventions mostly consistently applied.	Inclusion of a wide range of research-informed literature, including sources retrieved independently. Selection of relevant and credible sources. Very good use of referencing conventions, consistently applied.	A comprehensive range of research informed literature embedded in the work. Excellent selection of relevant and credible sources. High-level referencing skills, consistently applied.	Outstanding knowledge of research-informed literature embedded in the work. Outstanding selection of relevant and credible sources. High-level referencing skills consistently and professionally applied.
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	Major gaps in knowledge and understanding of material at this level. Substantial inaccuracies.	Gaps in knowledge, with only superficial understanding. Some significant inaccuracies.	Evidence of basic knowledge and understanding of the relevant concepts and underlying principles.	Knowledge is accurate with a good understanding of the field of study.	Knowledge is extensive. Exhibits understanding of the breadth and depth of established views.	Excellent knowledge and understanding of the main concepts and key theories. Clear awareness of challenges to established views and the limitations of the knowledge base.	Highly detailed knowledge and understanding of the main theories/concepts, and a critical awareness of the ambiguities and limitations of knowledge.
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	Unsubstantiated generalisations, made without use of any credible evidence. Lack of logic, leading to unsupported/missing conclusions. Lack of any attempt to analyse, synthesise or evaluate.	Some evidence of analytical intellectual skills, but for the most part descriptive. Ideas/findings sometimes illogical and contradictory. Generalised statements made with scant evidence. Conclusions lack relevance.	Evidence of some logical, analytical thinking and some attempts to synthesise, albeit with some weaknesses. Some evidence to support findings/views, but evidence not consistently interpreted. Some relevant conclusions and recommendations, where relevant	Evidence of some logical, analytical thinking and synthesis. Can analyse new and/or abstract data and situations without guidance. An emerging awareness of different stances and ability to use evidence to support the argument. Valid conclusions and recommendations, where relevant	Sound, logical, analytical thinking; synthesis and evaluation. Ability to devise and sustain persuasive arguments, and to review the reliability, validity & significance of evidence. Ability to communicate ideas and evidence accurately and convincingly. Sound, convincing conclusions / recommendations.	Thoroughly logical work, supported by evaluated evidence. High quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Strong, persuasive, conclusions, justifiable recommendations.	Exceptional work; judiciously selected and evaluated evidence. Very high quality analysis, developed independently or through effective collaboration. Ability to investigate contradictory information and identify reasons for contradictions. Highly persuasive conclusions
4. Practical Application and Deployment Effective deployment of appropriate methods, materials, tools and techniques; extent of skill demonstrated in the application of concepts to a variety of processes and/or contexts; formulation of innovative and creative solutions to solve problems.	Limited or no use of methods, materials, tools and/or techniques. Little or no appreciation of the context of the application.	Rudimentary application of methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of the context of the application.	An adequate awareness and mostly appropriate application of well-established methods, materials, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of standard methods, materials, tools and/or techniques. Good appreciation of the context of the application, with some use of examples, where relevant.	A very good application of a range of methods, materials, tools and/or techniques. Very good consideration of the context of the application, with perceptive use of examples, where relevant. Evidence of some innovation and creativity.	An advanced application of a range of methods, materials, tools and/or techniques. The context of the application is well considered, with extensive use of relevant examples. Application and deployment extend beyond established conventions. Innovation and creativity evident throughout.	Outstanding levels of application and deployment skills. Assimilation and development of cutting edge processes and techniques.
5. Skills for Professional Practice Demonstrates attributes expected in professional practice including: individual initiative and collaborative working; deployment of appropriate media to communicate (including written and oral); clarity and effectiveness in presentation and organisation.	Communication media is inappropriate or misapplied. Little or no evidence of autonomy in the completion of tasks. Work is poorly structured and/or largely incoherent.	Media is poorly designed and/or not suitable for the audience. Poor independent or collaborative initiative. Work lacks structure, organisation, and/or coherence	Can communicate in a suitable format but with some room for improvement. Can work as part of a team, but with limited involvement in group activities. Work lacks coherence in places and could be better structured.	Can communicate effectively in a suitable format, but may have minor errors. Can work effectively as part of a team, with clear contribution to group activities. Mostly coherent work and is in a suitable structure.	Can communicate well, confidently and consistently in a suitable format. Can work very well as part of a team, with very good contribution to group activities. Work is coherent and fluent and is well structured and organised.	Can communicate professionally and, confidently in a suitable format. Can work professionally within a team, showing leadership skills as appropriate, managing conflict and meeting obligations. Work is coherent, very fluent and is presented professionally.	Can communicate with an exceptionally high level of professionalism. Can work exceptionally well and professionally within a team, showing advanced leadership skills. Work is exceptionally coherent, very fluent and is presented professionally.

MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.		
N/A		
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.		
Section 1: Explanation of first order system – (/10) Section 2: Explanation of DC motor model – (/10) Section 3: Explanation of types of speed controllers – (/10)	30	
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence		
Section 1: Testing of first order system – (/10) Section 2: Testing of DC motor model – (/10) Section 3: Testing of speed controllers – (/20) Section 4: Conclusions and recommendations – (/10)	50	
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.		
Sections 1, 2 and 3: Use of Simulink and presentation quality of results - (/10)	10	
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.		
All sections – (/10)	10	

Assignment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		%
	Up to one week late		
	1 st /2 nd /3 rd attempt?	1st	

SPECIFIC LEARNING OUTCOMES FOR IENG

This section lists the IEng learning outcomes for full accreditation that are relevant to the assignment. The marks allocated are extracted from the Marking Criteria and Student Feedback form. The grade awarded for the particular LO is also shown. These grades are then transferred onto a 'global' sheet related to each student ensuring all IEng LO's are assessed at least twice across all modules

Code	Learning Outcome	Relevant Tasks in Assignment	Marks available	Marks awarded	Grade awarded
Science & Mathematics					
SM1i	Knowledge and understanding of the scientific principles underpinning relevant current technologies, and their evolution	Sections 1,2,3: Knowledge and understanding	30		
Engineering Analysis					
EA1i	Ability to monitor, interpret and apply the results of analysis and modelling in order to bring about continuous improvement	Sections 1,2,3: Analysis	40		
EA3i	Ability to use the results of engineering analysis to solve engineering problems and to recommend appropriate action	Section 4: Conclusions and recommendations	10		
Design					
Economic, Legal, Social, Ethical and Environmental context					
Engineering Practice					