TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

LABORATORY WORK OF Control System

by

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PREFACE

Teaching Instructional Design (BRP) of Laboratory Work of Control System is designed as a reference for the studying process in the course Laboratory Work of Control System in the Undergraduate Physics Program at FMIPA UI who can be followed by students taking the concentration of Instrumentational Physics in the 7^{th} term and has taken the pervious courses of Electronics 2.In this course, students will gain first-hand experience in using Matlab and LabVIEW to create a systematic representation of transfer functions, state variables, system response, control techniques, determining the parameters of a PID with 3 different methods which is Trial and Error, Direct Synthesis, and Zieger Nichols Correction We hope this BRP can be used as a reference both for the teacher and the student and anyone who hopes to learn Embedded Systems.

Depok, November 2016

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I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Laboratory Work of Control System
3.	Course Code	:	SCFI603726
4.	Semester	:	6
5.	Credit	:	1 credit
6.	Teaching Method(s)	:	Laboratory Work, Circuit Simulations, Writing Reports, Individual Tasks, Presentation, and Hand-Written Exam
7.	Prerequisite course(s)	:	Electronics 2
8.	Requisite for course(s)	:	-
9.	Integration Between Other Courses	:	-
10.	Lecturer(s)	:	Surya Darma, M.Si.
11.	Course Description	:	After finishing this course, students taking the concentration of Instrumentational Physics in the 7^{th} term is able to explain the principals of a control system, select and chose the transfer function and the control system for specific applications, and is able to design a control system for a certain proces. The instructional language used in this course will be the Indonesian language.

II. Course Learning Outcome (CLO) and Sub-CLOs

1. CLO

After finishing this course, students are ably to apply the basic principles of control systems for identifying and designing a continuous linear process that is continuous and simple that has a fast and slow response towards time. (C4).

2. Sub-CLOs

1. Able to explain the basic principles of Control Systems. (C2)
2. Able to determine and select the transfer function and control system of certain applications. (C3)
3. Able to design a control system for a certain process. (C4)

III. Teaching Plan

Week	Sub-CLO	Study Materials	Teaching Method	Time Required	Learning Experiences (*O-E-F)	Sub-CLO Weight on Course (%)	Sub-CLO Achievement Indicator	References
1	1	Introduction to LabVIEW and MATLAB a. Introduction to LabVIEW b. Introduction to MATLAB	Laboratory work, simulations, creating a report	200 minutes	10% O, 60% L, 30% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 1, No. 2, No. 3, No. 4
2	2	State Variables a. Introduction to the variables in a control system b. Signal-Flow graphs and Block Diagram Models c. Time Response and Condition Transition Matrix d. Techniques for Linearizing Systems	Laboratory work, simulations, creating a report	200 minutes	10% O, 60% L, 30% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 3, No. 4
3	2	Times Response Towards Various Standard Signals and Response System Control Towards	Laboratory work, simulations, creating a report	200 minutes	10% O, 60% L, 30% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 3, No. 4

		Various Standard Signals a. Signal Testing for Time Response and Control Systems b. Steady State Errors c. Transient Response for a Prototype d. Controlling the speed and position of a DC Motor						
4	2	PID (Proportional, Integral and Differential) and determining the PID Parameters (Trial and Error) a. Operational Systems b. Performance Criterions for a Closed System c. Model-Based Design Methods d. Controller Tuning Relations	Laboratory work, simulations, creating a report	200 minutes	10% O, 50% L, 40% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 3, No. 4, No. 5
	Mid Term Exam							
6	2	Determining the parameters for a PID using the Direct Synthesis and	Laboratory work, simulation	200 minutes	10% O, 50% L, 40% U	12	Able to report the result of the experiment and simulate it in a report based on	No. 3, No. 4, No. 5

		Ziegler Nichols Reaction Curve Method and applying it towards a DC motor a. Standard Model for a Transfer Function b. Applying the PID c. Direct Synthesis d. Ziegler Nichols Reaction Curve e. Techniques for data processing	s, creating a report				the rules that apply	
7	2	Controlling an Inverted Pendulum a. Force Analysis and System Equations b. State Space c. Transfer Functions d. Controlling an Inverted Pendulum	Laboratory work, simulations, creating a report	200 minutes	10% O, 50% L, 40% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 3, No. 4, No. 5
8	2	HVAC (Heating, Ventilation and Air Conditioning) a. Process Control b. Motion Control c. Task Based Control d. HVAC Control	Laboratory work, simulations, creating a report	200 minutes	10% O, 50% L, 40% U	12	Able to report the result of the experiment and simulate it in a report based on the rules that apply	No. 3, No. 4, No. 5, No. 6
9	2	Capita Selecta a. VTOL Control	Laboratory work, simulation	200 minutes	10% O, 50% L, 40% U	12	Able to report the result of the experiment and	No. 3, No. 4, No. 5, No. 6

		b. Mechatronics Sensor and Control c. EMG Signal Processing (Myoelectric Control)	s, creating a report				simulate it in a report based on the rules that apply	
10	**Final Exam**							

*) O : Orientation
E : Exercise (Quiz)
F : Feedback

Refences:

1. National Instruments Corporation, LabVIEW Fundamentals, ni.com, 2005
2. Sulaymon Eshkabilov, Beginning MATLAB and Simulink: From Novice to Professional, Apress, Fargo, USA, 2019
3. Dorf, Richard C., and Bishop, Robert H., Modern Control System, 13th ed., Prentice Hall, 2017.
4. Golnaraghi, Farid., and Kuo, Benjamin C., Automatic Control System, 10th ed. McGraw Hill Education., 2017.
5. Seborg, Dale E., Edgar, Thomas F., and Mellichamp, Duncan A., Process Dynamics and Control, 4th ed., John Wiley & Son., 2017.
6. Quanser, QNET DC Motor Trainer, QNET Rotary Pendulum Trainer, QNET Heating and Ventilation Trainer, 2011.

IV. Assignment Design

Week	Assignment Name	Sub-CLO	Assignments	Scopes	Working Procedure	Deadline	Outcome
2-11	Laboratory Work Report	1-5	Create a report based on the rules that apply	• Introduction towards LabVIEW and MATLAB • System Representation and Transfer Function • State Variables • System Response towards various Standard Signals • Techniques for controlling the System Response towards various Standard Signals. • PID • Determining the PID Parameters • Application towards the DC Motor • Inverted Pendulum Control • HVAC	Individual Tasks at home	1 week	Laboratory Work Report submitted in EMAS
13	Final Project	1-5	Creating an embedded system that is applicable for day-to-day uses using the materials studied throughout the course	The whole material studied throughout the course	Designing the final project as a group and present, write a proposal as well as a paper as a group	1 semester	The final project, proposal and paper is uploaded in EMAS

V. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
Pre-test	1-2	Pre-test questions	1 every week	5
Laboratory Work	1-2	1. Preliminary Report 2. Laboratory Work 3. Final Report	1 every week	70
Final Project	1-3	1. Proposal 2. Paper 3. Presentation 4. Demonstration	1 in the whole term	25
Total				**100**

VI. Rubric(s)

A. Criterions for the Group Project Presentation

Grade	Presentation Performance
>90	If the student is able to fulfill above 90% of the rules that apply in creating a report.
70-89	If the student is able to fulfill between 70% and 89% of the rules that apply in creating a report.
60-69	If the student is able to fulfill between 60% and 69% of the rules that apply in creating a report.
55-59	If the student is able to fulfill between 55% and 59% of the rules that apply in creating a report.
50-54	If the student is able to fulfill between 50% and 54% of the rules that apply in creating a report.

B. Criterions for the Proposal and Paper for the Final Project

Criteria	A (90)	B (75)	C (60)	D (50)

Workflow	Information being given is explained effectively with a good structure from how the paragraphs is written and the transitions between information hence being able to understand the context easily. A brief summary is given first so that the reader is able to continuously understand the report easily.	The information is provided logically in the paragraphs and transitions. Throughout the report, information is once or twice confusing to the reader.	Information is widely spread hence needing a more compact structure.	There is no obvious order that is written from the paragraphs and the transitions hence the reader is not able to find an ideal flow of how the system works. The details are unorganized and very difficult to comprehend.
Quality of Information	The details provided are compact and very specific, not wasting any space or words, providing only important details about the project.	There are a few details that is unimportant towards the project.	The details are vague and quite difficult to understand.	Unable to find a structured explanation that provides the details of the project.
Introduction	The preliminary paragraph's written are very focused towards the subject and increases the quality of the report.	The preliminary paragraph is stated with focus.	The preliminary paragraph is unclear.	The preliminary paragraph is unclear and does not give any impact towards the

				report.
Conclusion	The conclusion is able to provide the end result of the project effectively while being interesting and providing clear information.	Able to conclude the important information provided in the report.	The final concluding paragraph has important information but as a whole, does not provide substantial information that concludes the report.	The concluding paragraph is unclear.
Use of Language: **Words Chosen** **Grammar** **Sentence Structuring**	Sentences used are grammatically complete and correct while providing a flow that is easily understandable for the reader. The words used in the sentences provide the exact information needed.	For a major part of the report, the sentences used are grammatically correct and provides a flow that is easily understandable but there are minor mistakes that can take the readers attention away. There are repetitive words and phrases used in the report.	Small mistakes in the structuring and grammar of the sentences are pretty common hence distraction the reader and taking the information away from the reader. There are repetitive words and phrases used commonly.	Major structural and grammar mistakes can commonly be found in the report hence distracting the reader from finding the meaning behind the report. Repetitive words and phrases are more commonly used in the report.
Usage of Pictures: **Numbers** **Graphs** **Pictures**	Every number, graph, and picture are used accurately, consistent with the text provided and has good quality. The labeling of the	Most of the numbers, graphs and pictures are accurate, consisted with the text and has good quality but a few labels are not precise and	Only a few numbers, graphs, and pictures are used accurately and consistently with the text. The labels are not correctly used in the	The numbers, graphs, and pictures have bad quality, inaccurate and has incorrect label usage or no labels at all.

	pictures are used precisely.	consistent.	report.	

C. Pre-test, Post-test, and Final Exam

1. Able to provide an opinion towards the answer of the question (25%)
2. Able to determine the basic concepts used to answer the question (35%)
3. Able to formulate the final answer towards the question (30%)
4. Able to use the correct units (10%)

D. Criterions for the Peer Review Form

Kriteria	**5**	**4**	**3**	**2**	**1**
Communication	The partner in the course is able to give an explanation that is specific and easy to understand while using helping instruments to explain the concepts easily.	The partner in the course is able to give specific and some are easy to understand explanations while using helping instruments to explain the concepts.	The partner in the course is not able to give a precise and specific explanation towards the concept. Rarely uses instruments to explain the concept.	The explanation given by the partner is not specific and hard to understand while infrequently using instruments to explain the concept.	The explanation given by the partners are incomprehensible and does not use any instruments to provide better explanation towards the concept.
Work Atmosphere	The partners uses polite words while interacting and is contributing actively while not dominating the discussion.	The partner uses polite words while interactive, actively contributes but sometimes dominate the discussion.	The partner sometimes uses impolite words while interacting, contributes less while dominating the discussion.	The partner uses impolite words while interacting, contributes less while highly dominating the discussion.	The partner uses impolite words while interactive, does not contribute at all towards the discussion while fully

					dominating the discussion.
Openness	The partner actively gives feedback while appreciating other people's opinion.	Most of the time, the partner gives feedback while appreciating other people's opinion.	The partner infrequently gives feedback while most of the times appreciates other people's opinion.	The partner rarely gives feedback while also rarely appreciates other people's opinion.	The partner does not give feedback while not appreciating other people's opinion.
Behavior	The partner cooperates throughout the experiment while accepting a specific task and is responsible towards it.	The partner cooperates throughout the experiment while accepting a specific task but is not very responsible towards it.	The partner is less likely to cooperate throughout the experiment even though he/she still accepts a certain specific task but is not very responsible	The partner rarely cooperates, does not want to accept a certain task.	The partner does not cooperate at all and denies any work given.

E. Criterions for the Psychometric Work throughout the Course

Criteria	**5**	**4**	**3**	**2**	**1**
Work	The student follows the whole procedure of the experiment correctly and consecutively.	The student follows parts of the procedure correctly and consecutively.	The student follows parts of the procedure correctly but not very consecutive.	The student follows most of the procedure incorrectly and inconsecutively.	The student doesn't follow the procedures at all.
Safety	The student is proceeds with caution throughout the whole	The student is proceeds with caution throughout the whole	The student is proceeds with less caution throughout the whole	The student rarely proceeds with caution throughout the whole	The student is not cautious at all hence endangering

	experiment and is aware of their surroundings.	experiment and is not fully aware of their surroundings.	experiment and is not fully aware of their surroundings	experiment and is not aware of their surroundings	their surroundings.
Report	The student is able to write the final results of the experiment completely and is easy to understand.	The student writes the final result of the experiment less completely but is still easily understandable.	The student writes the final result of the experiment less completely but is hard to comprehend.	The student only writes parts of the final result of the experiment and is very hard to comprehend.	The student does not write any of the results found throughout the experiment.
Student Activity	The student actively works while showing interest towards the experiment and actively discusses with others.	The student is less active but shows interest towards the experiment and still actively discuss about the experiment.	The student is sometimes active and shows interest towards the experiment and still actively discuss about the experiment.	The student is rarely active, shows less interest towards the experiment, and rarely discusses about the experiment.	The student is inactive and shows no interest towards the experiment.