



**TEACHING INSTRUCTIONAL DESIGN (BRP)
COURSE
LABORATORY WORK OF SENSORS AND ACTUATORS**

by

Surya Darma, M.Si.

**Undergraduate Program in Physics
Faculty of Mathematics and Natural Sciences
Universitas Indonesia
Depok
November 2016**

PREFACE

Teaching Instructional Design (BRP) of Laboratory Work of Sensors and Actuators is designed as a reference for the studying process in the course Laboratory Work of Sensors and Actuators in the Undergraduate Physics Program at FMIPA UI who can be followed by students taking the concentration of Instrumentational Physics in the 7th term and has taken the pervious courses of Electronics 2. In this course, students will gain first-hand experience in studying the characteristics of sensors and apply it in a measurement circuit as well as apply actuators to respond to the data received by the sensors. This course gives students the ability to design electrical circuits that apply sensors and actuators as well as use it to monitor physical units, calculation, graphs, analyzation, and conclusion based on the result of the experiments. Those abilities is hoped to explain the physical concepts that corelates with the physical sensors and actuators used in this course. 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

Surya Darma, M.Si.

I. General Information

1. Name of Program / Study Level : Physics / Undergraduate
2. Course Name : Laboratory Work of Sensors and Actuators
3. Course Code : SCFI603723
4. Semester : 7
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 7th term is able to precisely explain the concepts of how sensors and actuators work, select and choose sensors and actuators for certain tasks and apply it for monitoring and measuring physical units. (C4). The instructional language used in this course will be the Indonesian language.

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

1. CLO

Students are able to precisely explain the concepts of how sensors and actuators work, select and choose sensors and actuators for certain tasks and apply it for monitoring and measuring physical units. (C4).

2. Sub-CLOs

1. Able to explain the basic principles of sensors and actuators. (C2)
2. Able to determine and select sensors and actuators of certain applications. (C3)
3. Able to design and create sensor systems to monitor and measure physical units. (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	Introduction towards the contract of the course							
2	1	Temperature Sensors a. Operational Principals of RTD b. Characteristics c. Circuit design using an RTD	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	The Specific Module, No. 2
3	2	Pressure and Weight Sensors a. Operational Principals of the Strain Gauge (SG) b. Characteristics c. Circuit design using a Strain Gauge d. Usage of SG sensor for measuring pressure e. Characteristics f. Circuit design for a Pressure Sensor	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	The Specific Module, No. 2
4	2	Light Sensors a. Operational Principals	Laboratory work, simulation	200 minutes	10% O, 60% L, 30% U	12	Able to report the result of the experiment and	The Specific Module, No. 2

		of the Light Sensor b. Characteristics c. Circuit design using a Light Sensor d. Techniques for data processing	s, creating a report				simulate it in a report based on the rules that apply	
5	2	Flow Sensor a. Operational Principals of the Flow Sensor b. Characteristics c. Circuit design using a Flow Sensor d. Techniques for data processing	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	The Specific Module, No. 2
6	2	Level Sensor a. Operational Principals of the Level Sensor b. Characteristics c. Types of Level Sensors d. Circuit design using a Flow Sensor	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	The Specific Module, No. 2
7	Mid Term Exam							
8	2	Magnet Sensor a. Operational Principals of the LVDT and	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 Specific Module, No. 2

		Hall Effect Sensor b. Characteristics c. Specific functions of the Magnet Sensor d. Circuit design using a Magnet Sensor e. Techniques for data processing					the rules that apply	
9	2	Proximity Sensor a. Operational Principals of the Proximity Sensor b. Characteristics c. Circuit design using a Proximity Sensor d. Techniques for data processing	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	The Specific Module, No. 2
10	2	Chemical Sensor a. Operational Principals of the Chemical Sensor b. Characteristics c. Circuit design using a Chemical Sensor d. Techniques for data processing	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	The Specific Module, No. 2

11	2	<p>Electric Actuators</p> <p>a. Operational Principals of the Electric Actuator</p> <p>b. Characteristics</p> <p>c. Circuit design using an Electric Actuator</p> <p>d. Techniques for controlling voltage / current</p>	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	The Specific Module, No. 2
12	2	<p>Hydraulic and Pneumatic Actuators</p> <p>a. Operational Principals of the Hydraulic and Pneumatic Actuators</p> <p>b. Characteristics</p> <p>c. Circuit design using Hydraulic and Pneumatic Actuator</p> <p>d. Techniques for controlling voltage / current</p>	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	The Specific Module, No. 2
13	Final Exam							

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

Refences:

1. Departemen Fisika FMIPA UI, Buku Panduan Praktikum Sensor dan Aktuator
2. Beckwith, T. G. , Marangoni, R. D. dan J. H. Lienhard V, Mechanical Measurements (I. Fundamentals of Mechanical Measurement, II. Applied Mechanical Measurements), Addison-Wesley Publishing Company, 6ed , 2006

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	<ul style="list-style-type: none"> • Temperature Sensors • Pressure and Weight Sensors • Light Sensors • Flow Sensors • Level Sensors • Magnet Sensors • Proximity Sensors • Chemical Sensors • Electric Actuators <ul style="list-style-type: none"> • Hydraulic Actuators • Pneumatic Actuators 	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	<ol style="list-style-type: none"> 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. Criteria 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. Criteria 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	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.

	given first so that the reader is able to continuously understand the report easily.			
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	The concluding paragraph is unclear.

			that concludes the report.	
Use of Language: Words Chosen Grammar Sentence Structuring	<p>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.</p>	<p>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.</p>	<p>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.</p>	<p>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.</p>
Usage of Pictures: Numbers Graphs Pictures	<p>Every number, graph, and picture are used accurately, consistent with the text provided and has good quality. The labeling of the pictures are used precisely.</p>	<p>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 consistent.</p>	<p>Only a few numbers, graphs, and pictures are used accurately and consistently with the text. The labels are not correctly used in the report.</p>	<p>The numbers, graphs, and pictures have bad quality, inaccurate and has incorrect label usage or no labels at all.</p>

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. Criteria 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	The partner cooperates throughout the	The partner is less likely to cooperate	The partner rarely cooperates,	The partner does not cooperate at

	experiment while accepting a specific task and is responsible towards it.	experiment while accepting a specific task but is not very responsible towards it.	throughout the experiment even though he/she still accepts a certain specific task but is not very responsible	does not want to accept a certain task.	all and denies any work given.
--	---	--	--	---	--------------------------------

E. Criteria 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 experiment and is aware of their surroundings.	The student is proceeds with caution throughout the whole experiment and is not fully aware of their surroundings.	The student is proceeds with less caution throughout the whole experiment and is not fully aware of their surroundings	The student rarely proceeds with caution throughout the whole experiment and is not aware of their surroundings	The student is not cautious at all hence endangering 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.
-------------------------	--	---	--	--	---