# TEACHING INSTRUCTIONAL DESIGN (BRP)

# COURSE

# DIGITAL SIGNAL PROCESSING

**by**

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**Depok**

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# PREFACE

The Teaching Instructional Design (BRP) for the Digital Signal Processing course was prepared to be used as a reference for learning the Digital Signal Processing course in the Undergraduate Physics Study Program of the Faculty of Mathematics and Natural Sciences UI which was followed by physics students majoring in physics system and instrumentation semester 7 on the condition that the student had taken the Physics course Modern, Mathematical Physics 2, and Electronics 2. In the Digital Signal Processing course, students will be taught about digital signal analysis methods in the discrete time domain and also discrete frequencies and how to apply the concept of mathematical transformations to digital filter applications appropriately. It is hoped that this BRP can become a reference or reference in the learning process for both lecturers as teachers and students as course participants so that the material is conveyed properly and perfectly..

Depok, November 24th 2016

**Adhi Harmoko Saputro, Ph.D.**

## I. General Information

| | | | |
|---|---|---|---|
| 1. | Name of Program / Study Level | : | Physics / Undergraduate |
| 2. | Course Name | : | Digital Signal Processing |
| 3. | Course Code | : | SCFI604715 |
| 4. | Semester | : | 7 |
| 5. | Credit | : | 2 Credits |
| 6. | Teaching Method(s) | : | Interactive lectures, lectures, question-based learning, self-directed study, discussion, independent assignments, and written examinations. |
| 7. | Prerequisite course(s) | : | Modern Physics, Mathematical Method in Physics 2, Electronics 2 |
| 8. | Requisite for course(s) | : | None |
| 9. | Integration Between Other Courses | : | None |
| 10. | Lecturer | : | Adhi Harmoko Saputro, Ph.D. |
| 11. | Course Description | : | After completing this lecture, physics students with a special interest in systems and physics instrumentation in semester 7 are able to analyze (C4) digital signals in the discrete time domain and discrete frequency and apply (C3) the concept of transformation for digital filter applications appropriately. The language of instruction used in this course is Indonesian. |

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

### A. CLO

Students are able to analyze (C4) digital signals in the discrete time domain and discrete frequency and apply (C3) the concept of transformation for digital filter applications appropriately. (ELO(s) 3, 5, 6, 8)

### B. Sub-CPMK

1. Able to apply (C3) basic electronic concepts for signal conditioning.
2. Able to apply (C3) mathematical physics concepts to the digital signal transformation method.
3. Able to analyze (C4) digital signals in discrete time and frequency domains using the Fourier transform method.
4. Be able to apply (C3) the concept of digital filters for linear time-invariant (LTI) systems.

## 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 | **Course Introduction** | | | | | | | |
| 2 | 1 | • Introduction of digital signals and systems | Interactive lectures, question-based learning, self-directed study, discussion | 100x2 minutes | 20% O, 60% E, 20% F | 8.33 | Able to describe digital signals and systems, especially linear time-invariant (LTI) systems. | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 3 | 1 | • ADC and DAC signal conversion | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain how to convert ADC and DAC signals | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |

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|---|---|---|---|---|---|---|---|---|
| 4 | 1 | • Discrete time systems and signals | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain discrete time systems and signals and their differences continuously. | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 5 | 2 | • Z transformation | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain the Z transformation method | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 6 | 2 | • Continuous time signal sampling | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain the continuous time signal sampling method | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 7 | 2 | • Application of the Z transformation for linear time-invariant (LTI) systems | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain the use of the Z transformation for a linear time-invariant (LTI) system. | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 8 | **Mid Term Exam** | | | | | | | |
| 9 | 3 | • Continuous time signal frequency analysis | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 6.25 | Be able to explain the continuous time signal frequency analysis method | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 10 | 3 | • Discrete time signal | Interactive lectures, question-based | 100 minutes | 20% O, 60% E, 20% F | 6.25 | Be able to explain discrete time | Oppenheim, A.V. and Schafer, R.W., *Discrete-* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | frequency analysis | learning, self-directed study, discussion | | | | signal frequency analysis method | *Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 11 | 3 | • Fourier transform for discrete time signals | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 6.25 | Be able to explain the Fourier transform principle for discrete time signals | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 12 | 3 | • Fourier analysis for discrete time signals | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 6.25 | Be able to explain the methods and results of Fourier analysis for discrete time signals | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 13 | 4 | • Filter concept | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain the basic principles of filters for digital systems | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 14 | 4 | • Finite Impulse Response (FIR) digital filter | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Able to explain FIR type digital filter | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 15 | 4 | • Infinite Impulse Response (IIR) digital filter | Interactive lectures, question-based learning, self-directed study, discussion | 100 minutes | 20% O, 60% E, 20% F | 8.33 | Be able to explain the IIR type digital filter | Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009. |
| 16 | **Final Exam** | | | | | | | |

*) O : Orientation
E : Exercise
F : Feedback

References:


1. Kehtarnavas, N., Digit*al Signal Processing System Design: LabVIEW-Based Hybrid Programming*, Academic Press, 2008.
2. Ingle, V.K., and Proakis, J.G., *Digital Signal Processing using Matlab*, Cengage Learning, 4th Ed., 2012.
3. Oppenheim, A.V. and Schafer, R.W., *Discrete-Time Signal Processing* (3rd Ed), Prentice Hall, 2009.

## IV. Assignment Design

| Week | Assignment Name | Sub-CLOs | Assignment | Scope | Working Procedure | Deadline | Outcome |
|---|---|---|---|---|---|---|---|
| 2-7, 9-15 | Individual Assignment | 1-4 | Doing homework | • The entire material coverage for the week | Individual Homework | 1 week | Answers uploaded on EMAS |
| 8 | Mid Term Exam | 1-2 | Written Examination | • Signal and system introduction<br>• ADC and DAC signal conversion<br>• Discrete time systems and signals<br>• Z transformation<br>• Continuous time signal sampling<br>• Application of the Z transformation for time-invariant linear (LTI) systems | Working on Mid Term Exam in EMAS | 100 minutes | Answers to questions uploaded on EMAS |
| 16 | Final Exam | 3-4 | Written Examination | • Continuous time signal frequency analysis<br>• Descrete time signal frequency analysis<br>• Fourier transform for discrete time signals<br>• Fourier analysis for discrete time signals<br>• Filter concept<br>• Finite Impulse Response (FIR) digital filter | Working on Final Exam in EMAS | 100 minutes | Answers to questions uploaded on EMAS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | • Infinite Impulse Response (IIR) digital filter | | | |

## V. Assessment Criteria (Learning Outcome Evaluation)

| **Evaluation Type** | **Sub-CLOs** | **Assessment Type** | **Frequency** | **Evaluation Weight (%)** |
|---|---|---|---|---|
| Assignment | 1-4 | Summary or Homework | 1 per week | 30 |
| Mid Term Exam | 1-2 | Exam questions at EMAS UI | 1 | 35 |
| Final Term Exam | 3-4 | Exam questions at EMAS UI | 1 | 35 |
| **Total** | | | | **100** |

## VI. Rubric(s)

### A. Criteria of Individual Assignment Score

| **Score** | **Answers Quality** |
|---|---|
| >90 | If students can complete more than 90% of the questions correctly |
| 70-89 | If students can complete more than 70% s.d. 89% of the questions correctly |
| 60-69 | If students can complete more than 60% s.d. 69% of the questions correctly |
| 55-59 | If students can complete more than 55% s.d. 59% of the questions correctly |
| 50-54 | If students can complete more than 50% s.d. 54% of the questions correctly |

### B. Mid Term Exam (UTS) and Final Term Exam (UAS)

1) Able to express ideas in solving problems (25%)
2) Be able to determine the right basic concepts in solving problems (35%)
3) Be able to formulate the final solution of problems correcting language errors (30%)
4) Able to use the appropriate important units and figures (10%)