TEACHING INSTRUCTIONAL DESIGN (BRP)

COURSE

EMBEDDED SYSTEM

by

Dr. Prawito Prajitno

Undergraduate Program in Physics
Faculty of Mathematics and Natural Sciences
Universitas Indonesia
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PREFACE

Teaching Instructional Design (BRP) of Embedded System is the continuation of the designed teaching system from the previous courses which is Electronics 1 and Electronics 2. In this course, students will learn the basic concepts of microcontroller architecture, learn how to use the interface of microcontrollers using peripheral components and its programming language, using both simple (Assembly language) and difficult (C language) types of languages. In the end of the course, students must design an application of instrumentation systems based on microcontrollers and present it in class. Aside from lecturing in class, students must use computers and interactive microcontroller simulations to apply the lessons proactively and understand every topic that is being discussed.

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, May 2016

Dr. Prawito Prajitno

I. General Information

1.	Name of Program / Study Level	:	Physics / Undergraduate
2.	Course Name	:	Embedded System
3.	Course Code	:	SCFI604723
4.	Semester	:	5
5.	Credit	:	3 credits
6.	Teaching Method(s)	:	Lecturing classes, individual tasks, and written exams.
7.	Prerequisite course(s)	:	Electronics 1 and Electronics 2
8.	Requisite for course(s)	:	Laboratory Work of Embedded System
9.	Integration Between Other Courses	:	Laboratory Work of Embedded System
10.	Lecturer(s)	:	Dr. Prawito Prajitno
11.	Course Description	:	Giving the basic concepts about embedded systems, examples of embedded systems, microprocessors and microcontrollers, microcontroller architecture, memory organization, minimum systems based on microcontrollers, instruction sets, parallel inputs and outputs, interrupts, Counters and Timers, Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC), interfacing external memory, interfacing external peripherals and devices, serial data communication such as : USART, SPI, I2C, 1-Wire, and Real-time Operating Systems (RTOS)

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

A. CLO

Students are able to understand problems and apply interfacing and programming methods in embedded systems effectively and efficiently. (C3) (ELO 3, 5, 6, 7)

B. Sub-CLOs

1	Explaining the basic concepts of Embedded Systems, FPGA, Microprocessors and Microcontrollers (C2 and C3)	1
2	Explaining the basic concepts of Microcontroller Architecture, Program Memory (FlashROM), Data Memory (RAM), EEPROM and Assembly Programming (C2 and C3)	1
3	Explaining the basic concepts of I/O Port Configuration, Manipulating I/O Ports and Software-based time delay (C2 and C3)	1
4	Explaining the basic concepts of Polling, Interrupts from External Hardware and the difference between both concepts (C2 and C3)	1
5	Explaining the basic concepts of Programming Styles, Data Types, Variables, Constants, I/O Port Programming, and the Look-Up Table (C2 and C3)	1
6	Explaining the basic concepts of Programming External Interrupts, Procedure and Function, Alphanumeric LCD Interfacing and Programming (C2 and C3)	1
7	Explaining the basic concepts of Timer Configuration, Counter Configuration, Applications of Timers and Counters, PWM-based Motor Control, and the Watchdog Timer (C2 and C3)	1
8	Explaining the basic concepts of ADC Settings, Free-Running Mode, Single-Conversion Mode, and DAC Interfacing (C2 and C3)	1
9	Explaining the basic concepts of Asynchronized Communication for Serial Data, USART Polling Mode, and USART Interrupt Mode (C2 and C3)	1
10	Explaining the basic concepts of SPI based Data Communication, SPI Applications towards the ADC and DAC, and Real Time Clock units (C2 and C3)	1
11	Explaining the basic concepts of I2C based Data Communication, Applications of SPI towards the ADC and DAC, and Programming on peripheral Devices (C2 and C3)	1
12	Explaining the basic concepts of 1-Wire based Data Communication and 1-Wire Interfacing on the DS1820 Sensor (C2 and C3)	1
13	Explaining the basic concepts of Real-Time Operating Systems (RTOS) and its Application on Embedded Systems	1
14	Designing simple Embedded Systems as a Group Task (C3)	1

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	Embedded Systems, FPGA, Microprocessors and Microcontrollers	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Embedded Systems b) FPGA c) Microprocessors d) Microcontrollers	No. 1
2	2	Microcontroller Architecture, Memory Organization, Minimum Systems, Assembly language and its sets of instructions	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Microcontroller Architecture b) Program Memory (FlashROM), Data Memory (RAM), EEPROM c) Assembly Programming	Chap1, Page 39
3	3	I/O Port Programming, Logic Instructions and Arithmetics	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) I/O Port Configuration b) I/O Port Manipulation	No. 1

							c) Software-based Delay Time	
4	4	External Hardware Interrupt	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Polling and Interrupt b) Interrupt Settings and its Applications	Chap 2 Page: 55
5	5	Embedded C Language	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Programming Styles b) Data Types, Variables and Constants c) I/O Port Programming d) Look-Up Table	Chap 3 Page 107
6	6	External Interrupt Programming	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Programming External Interrupt b) Procedures and Functions c) Alphanumeric LCD Interfacing and Programming	No. 1

7	7	Timers and Counters	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Timer Configuration b) Counter Configuration c) Applications of the Timer and Counter d) PWM-based Motor Control e) Watchdog Timer	Chap 4 Page: 139 Chap 5 Page 161
8	**Mid Term Exam**							
9	8	The Analog to Digital Converter (ADC) and the Digital to Analog Converter (DAC)	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) ADC setting, Free-Running Mode, and Single-Conversion Mode b) DAC Interfacing	Chap 10 Page 363
10	9	Asynchronized Serial Data Communication	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Asynchronized Serial Data Communication b) USART Polling Mode and USART	No. 1, Chap 7 Page 255

							Interrupt Mode	
11	10	Serial Peripheral Interface (SPI)-based Synchronous Data Communication	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) SPI Bassd Data Communication b) Applications of the SPI on ADC, DAC and the Real Time Clock Unit	No. 2, Chap 1 Page 1
12	11	Inter Integrated Circuit (I2C)-based Synchronous Data Communication	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) I2C based Data Communication b) I2c Interfacing and Programming on Peripheral Devices	No. 1, Chap10 Page 385
13	12	1-Wire Data Communication	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) 1-Wire based Data Communication b) 1-Wire Interfacing on the	No. 2, Chap 2 Page: 97

							DS1820 Sensor	
14	13	Introduction to the Real-Time Operating System (RTOS)	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	7	Able to explain the basic concepts of: a) Real-Time Operating System (RTOS) b) Applications of the RTOS on Embedded Systems	No.1, Chap 12 Page 429
15	14	Group Project	Lecturing classes and individual tasks	150 minutes	50% O, 10% E, 40% F	9		No. 1, Chap 9 Page 353
16	**Ujian Akhir Semester**							

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

Refences:

1. Mazidi, M.A, Naimi, S., *The AVR Microcontroller and Embedded Systems Using Assembly and C*, Prentice Hall, 2011.
2. Barnett, R.H, Cox, S, O'Cull, L, *Embedded C Programming and The Atmel AVR, 2nd edition,* Thomson Delmar Learning, 2007
3. Maxim Integrated, *DS-1820 High-Precision 1-Wire Digital Thermometer*, Maxim Integrated Product, 2015.
4. Barrr, R, *Mastering the Free RTOS Real Time Kernel, A Hands-On Tutorial Guide*, Real Time Engineers Ltd. 2016

IV. Assignment Design

Week	Assignment Name	Sub-CLO	Assignments	Scopes	Working Procedure	Deadline	Outcome
1-14	In-Class Quizzes, Homework and Simulations	1-13	Questions	Summarize the specific week's material and simulations	Individual Tasks	1 week	Quiz results in class and program design
15	Group Project	14	Final Project	Designing the equipment	Group Task	1 week	Student Power-point and results of the presentation

V. Assessment Criteria (Learning Outcome Evaluation)

Evaluation Type	Sub-CLO	Assessment Type	Frequency	Evaluation Weight (%)
In-class quiz	1-7 and 8-13	Evaluation Sheet	6	10
Homework and Simulations	2-13	Evaluation Sheet	12	10
Group Project	14	Evaluation Sheet	1	20
Mid-Term Exam	1-7	Essay Questions	1	30
Final Exam	8-13	Essay Questions	1	30
Total				**100**

VI. Rubric(s)

A. Criterions for the Group Project Presentation

Grade	Presentation Performance
85-90	The group is able to give a logical, clear, and on time presentation. The group is also able to answer the questions from other students or the teacher
75-84	The group is able to give a logical and clear explanation while being able to answer questions from other students or the teacher but is not able to manage their time correctly.
65-74	The group is able to give a clear explanation but isn't able to explain the logic behind their project

55-64	The group isn't able to give a clear explanation nor explain the logic behind their group project nor having good time management skills
<55	

B. Criterions for the Mid-Term Exam and Final Exam

Grade	Quality of Answer
100	The answers are precise, every definition and main components are included
76-99	The answers precise enough, all definitions and main components that are needed to answer the question are almost precise
51-75	The answers are less precise, the definitions and main components that are needed to answer the question are less precise
26-50	The answers are very unprecise, the definitions and main components that are needed to answer the questions are missing a lot of details
<25	Wrong answer

Attachment 1. Example Questions

Quiz 2 - Logic and Arithmetic Instructions

1. Write a macro using the #define directive to alias the function putchar() with a function named send_the_char()Write a function that prompts the user for two integer values, adds them together, and prints the values and their sum in the format “The values A + B = C”, where A, B, and C are decimal integers.
2. Write a function that uses scanf() to receive a date in the format “MM/DD/YYYY” and then uses printf() to display the date “DD-MM-YY”.
3. Write a function that prints its compile date and time. Use the compiler’s internal tag names to get the date and time values.
4. Write a function that prints its compiled memory model and optimizer settings.
5. Write a function that inputs a 16-bit hexadecimal value and then prints the binary equivalent.