Program: ECE
Degree Level: Master

Faculty/College: TGGS

Course 090245336

Embedded Software

King Mongkut's University of Technology North Bangkok

The Sirindhorn International Thai-German Graduate School of Engineering

Electrical and Software Systems Engineering Program

Section 1: General Information

1. Course code and course title

090245336 Embedded Software

2. Total credits

3 credits ☐ (2-2-5) ☑ (3-0-6) ☐ (3-0-9) ☐ (2-3-7)

3. Curriculum and course category:

Curriculum: *Master of Engineering in Electrical and Software Systems Engineering*

Course category: Required Courses

☐ Core Course ☐ Specific Core Course

☐ Industrial Internship ☐ Master Thesis

Elective Courses

☑ General Elective ☐ Specific Elective ☐ Other Elective

4. Course coordinator/ Instructors

Course Coordinator: _____

Instructor(s): Asst. Prof. Dr.-Ing. Chayakorn Netramai

5. Semester/ year of study

☑ Semester 1 (Aug. to Dec.) ☐ Semester 2 (Jan. to May) Academic Year: 2021

6. Pre-requisite (if any)

☑ No ☐ Yes, please provide: .....

7. Co-requisites (if any)

☑ No ☐ Yes, please provide: .....

8. Venue of study

Lecture Day/Time: Thursdays at 09.00-12.00

☐ On-site: Lecture Room No.:...806..... Floor:...8.....

☑ TGGS, KMUTNB ☐ Faculty of Engineering, CU ☐ RWTH

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☑ On-line*: Teaching Media: ☐ Microsoft Teams ☐ Google Meet ☑ Zoom ☐ Webex ☐ Other (specify) .....

*Remark: * During COVID-19, the teaching can be on-site and/or on-line according to TGGS Policy.*

9. Information for quality assurance in education

This course shows evidence of:

- ☑ Development of implementation from previous practices, e.g. the improvement of class teaching, course content, content classification and methods used for learning assessment
- ☐ Involvement from professional bodies/ external agencies in instruction; thus Enhancing student academic and professional experiences
- ☑ Integration of research or creative activities with instruction; use of research-based learning management; knowledge management practices for learning improvement
- ☐ Integration of academic services and course implementation
- ☐ Combination of cultural heritage preservation efforts into instruction or student activities

10. Date of latest revision:

July 2021

Section 2: Course Description and Implementation

1. Course Description *(As written in the Official Approved Curriculum)*

Introduction to embedded systems and its current research issues. introduction to microcontroller. Structure and component of a microcontroller. Digital I/O. Analog I/O. Timer and counter. Interrupt. Serial and parallel communications. Peripheral device interface. PWM and close-loop control. Real-time design consideration. Microcontroller software testing and debugging.

2. Number of hours per semester

Lecture	Practice	Self-study
45 hours/ semester (*3 hours/week**)		*90 hours/ semester* (*6 hours/week**)

*Remark: * Based on 15 weeks of lecture*

Course Category: ☑ Lecture ☐ Practice ☐ Laboratory

Course Evaluation: ☑ A-F ☐ S/U ☐ P

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3. Number of hours per week for academic guidance to individual students

☐ 1. Giving academic advice (minimally number hour per week) during the office hour

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☑ flexible upon request

The student can arrange the time via email for the meeting date/time.

☐ 2. Adopting information technology-based academic advising

☐ Email: chayakorn.n@tggs.kmutnb.ac.th

☐ Phone:

☐ Communication Apps: Line ID: 0806209879

(Please notify the lecturer when adding the line.)

☐ Meeting Online: The platform will be informed to students upon the request.

☐ Other (specify) .....

☐ 3. .....

4. Course Learning Outcomes (CLOs): Students should be able to:

CLO 1. To understand the theoretical concepts in the followings:

- Definition and characteristics of embedded system
- Components of microcontroller
- Embedded software technologies

CLO 2. To apply the knowledge in embedded system component and software technologies to actual engineering problems including at the industries.

CLO 3. To analyze and employ embedded software solutions suitable to the engineering problems.

Remark: 1. Guidelines according to Bloom's Taxonomy is available at https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html

2. For the master level course, CLOs should be "apply" and "analyze" or possibly to consider the doctoral CLOs "evaluate" and "create". "Remember" and "Understand" are for the undergraduate level courses, however, they can be implemented only at the beginning of the course.

3. CLOs can be defined as many as appropriated for the course.

5. The mapping between Expected Learning Outcomes (ELOs) from the curriculum and Course Learning Outcomes (CLOs)

Table 5.1 ELOs-CLOs Consistency *(for a subject-specific course/ a specific curriculum)*

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3
ELO1	✓	✓	
ELO2			
ELO3			
ELO4			
ELO5		✓	✓
ELO6		✓	✓
ELO7		✓	✓
ELO8			
ELO9			
ELO10			

Remark: All ELOs and ELOs for the course (highlighted row) are as written in the Official Approved Curriculum.

Table 5.2 Mapping desirable characteristics of KMUTNB graduates and CLOs *(for non-specific courses designed for various curriculums)*

Consistency between desirable characteristics of KMUTNB Graduates - CLOs	CLO 1	CLO 2	CLO 3
1. **Professional credentials with critical thinking skills**	✓	✓	✓
2. **Integrity and social responsibility**			
3. **Innovative and technopreneur mindset**			
4. **Global Competence**			✓

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Section 3: Student Improvement in relation to Course Learning Outcomes (CLOs)

Organizing learning to develop skills/ knowledge; evaluation of CLOs in accordance with the ones identified in Section 2.4

Course Learning Outcomes (CLOs)	Teaching Methods compliant with CLOs	Evaluation Methods compliant with CLOs
CLO 1	• Lecture* • Active learning** • In-class exercises • Individual and/or group assignment • Additional reading assignments from research and/or literature journals	• Assignment evaluation • Assessment of assigned exercises • Exam****
CLO 2	• Case studies, project-based learning • In-class exercises • Individual and/or group assignment • Additional reading assignments from research and/or literature journals • Group discussions	• Assignment evaluation • Assessment of assigned exercises • Exam****
CLO 3	• Lecture on how to apply theoretical concepts to the industrial applications • Demonstration on the use of computer software for various embedded software applications • In-class exercises • Group discussions on project updates • Mentoring on the problem solving	• Assignment evaluation • Assessment of assigned exercises • Class project to analyze and implement embedded software solution for selected tasks

*Remark: * Lecture on the concept of the topic is introduced with basic or fundamental definitions, visualization and correlations. For the complicated equation, the derivation from the basic laws can be shown to students. So, the students do not memorize the equations but understand the basic concept and basic equation. The lecturer will introduce the advanced and new concepts, technologies, and findings to students from publications such as journals and websites and from the research and industrial experiences.*

*** Active learning by asking questions related to the topic in the lecture and encouraging the students to response to the questions. If the students cannot response with answers, then the lecturer will give some guidance until the students can response.*

**** Quiz in the closed-book format on the basic concepts and equations with simple problem solving to evaluate their learning. The solution will be given to students after grading, so they can identify their mistakes and weakness.*

***** Exam on the basic concepts and equations with simple problem solving in the closed-book format as a review, whereas the complicated/integrated problem solving will be worked in the open-book format.*

Section 4: Lesson Plan and Evaluation

1. **Lesson Plan**

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
1	Introduction to embedded systems and its current research issues	CLO 1	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
2	Introduction to microcontroller	CLO 1	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
3	Structure and component of a microcontroller	CLO 1	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
4	Digital IO	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
5	Analog IO	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
6	Timer and counter	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
7	Interrupt	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
8	Midterm Exam	CLO 1, CLO 2	3.0	Written exam	Dr. Chayakorn

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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
9	Serial and parallel communications	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
10	Peripheral device interface part 1: basic input output devices	CLO 1	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
11	Peripheral device interface part 2: digital output control	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
12	PWM and close-loop control	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
13	Network connectivity for embedded systems	CLO 1, CLO 2	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
14	Real-time design consideration: hardware consideration	CLO 2, CLO 3	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
15	Real-time design consideration: efficient software design	CLO 2, CLO 3	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
16	Microcontroller software debugging	CLO 2, CLO 3	3.0	Lecture presentation slides Examples & In-class exercises Homework assignment	Dr. Chayakorn
17	Final Exam	CLO 3	3.0	Project presentation	Dr. Chayakorn
		Total	51.0		

2. **Evaluation Plan (in accordance with OBE 2 mapping framework)**

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 1, 2	Assignments	4-7, 9-13	50%

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 1, 2,	Written exams	8	50%
CLO 3	Project	17	25%

Section 5 Teaching/Learning Resources

Textbooks and materials

[1] Valvano, Embedded Microcomputer Systems: Real Time Interfaceing, 2007

[2] Navet and Simonot-Lion, Automotive Embedded Systems Handbook, 2009

[3] Qiu and Li, Real-Time Embedded Systems: Optimization, Synthesis, and Networking, 2011

[4] www.arduino.cc

[5] www.atmel.com

Section 6 Course Evaluation and Improvement

1. **Course evaluation by students**

The students will have an opportunity to evaluate the effectiveness of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the course's effectiveness.

2. **Strategies for assessing learning management**

The students will have an opportunity to evaluate the teaching of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the teaching as well as returning to the lecturer for further improvement.

3. **Improvement schemes of course implementation**

The evaluation from the students including the grading will be submitted to the curriculum meeting for reviewing and brainstorming to improve teaching of each course. Comments and suggestions given by the curriculum meeting will be informed to the responsible lecturer of each course.

4. **Verification of students' learning outcomes, referred to OBE 2 and 3**

The grading of this course will be evaluated and reviewed by the Department meeting and the TGGS executive board meeting in order to verify its appropriateness before the final approval.

5. Course review and improvement plans

The results of the grading evaluation and student evaluation will be submitted to the curriculum meeting for reviewing and brainstorming to improve the effectiveness of the offered courses. Comments and suggestions will be informed to the responsible lecturer of each course.