# SYLLABUS

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| **Date/ Revision** | 27 January 2017 |
| **Faculty** | Life Sciences |
| **Approval** | Dean of The Faculty of Life Sciences |

**SUBJECT : EMBEDDED SYSTEM DESIGN**

## 1. Identification of Subject:

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|---|---|
| Name of Subject | : Embedded System Design |
| Code of Subject | : EBSY-2900 |
| SKS / ECTS | : 3/ 4 |
| Semester | : 4 |
| Study Program | : Biomedical Engineering |
| Lecturer | : Handri Santoso, Ph.D |

## 2. Competency

After having the course, students are expected to:

a) Understand the what is an embedded system.
b) Understand the fundamental concepts of embbed systems.
c) Present the learning objectives, focus on problem solving, clearly illustrated examples of specification and modelling embedded system.
d) Understand about embedded system hardware and system software
e) Develop students' ability to make an application and solve problems using embedded system.
f) Give students hands on experience with programming, electronic device and integrated hardware and software in one embedded system

## 3. Description of Subject:

This course covers hardware as well as software aspects of embedded systems. The course focuses on the fundamental bases of software and hardware. Specific products and tools are mentioned only if they have outstanding characteristics. This course goes beyond teaching embedded system design by programming micro-controllers. With this approach, we would like to make sure that the material taught will not be outdated too soon. The concepts covered in this course should be relevant for several years to come. A key goal of this course is to provide an overview of embedded system design and to relate the most important topics in embedded system design to each other. The course should also help to bridge the gap


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between practical experiences with programming micro-controllers and more theoretical issues. Furthermore, it should help to motivate students to look at more details.

## 4. Learning Approach

Approach : Combination of Expository - inquiry and colaborative, hand on programming
Method : Discussion, question answer, sample problem, group work
Student Task : Home work, presentation
Media : LCD projector, film.

## 5. Evaluation

a) Absence maximum : 25%
b) Homework, Classwork, Quiz : 40 points
c) Final Examination : 60 points

Total : 100 points

## 6. Contents/ Topics of Lecturing:

| Week | Topics | Content | Text Book Chapter | Remark |
|---|---|---|---|---|
| 1 | Introduction | • Application areas, examples, education concept<br>• Common characteristics<br>• Challenges in embedded system design<br>• Design flows | Ch 1 | Homework |
| 2 - 3 | Specification and Modelling | • Requirment, models of computation<br>• The observer pattern, a case against imperative specification<br>• Early design phases: text, use cases, time-distance charts, sequence charts<br>• Communicating finite state machines (CFSMs): Timed automata<br>• State charts: implicit shared memory communication, modelling of hierarchy<br>• State charts timers and semantics, synchronous languages<br>• SDL: A case of message passing<br>• Dataflow: scope, Kahn process networks (KPN)<br>• Dataflow: synchronous (or "static") data flow, SDF, Simulink, RTW<br>• Petri nets: Introduction<br>• Petri nets: condition/event nets<br>• Petri nets: place transition nets<br>• Petri nets: predicate/transition nets, evaluation | Ch 2 | Homework |


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| | | • Discrete Event Modelling, VHDL<br>• Discrete Event Modelling, IEEE 1164<br>• Imperative (or von Neumann) model of computation, Comparison of models<br>• comparison of models of computation | | |
| 4 | Embbeded Systems hardware | • Sensors<br>• discretization of time: sample-and-hold circuits<br>• discretization of values: A/D-converters<br>• discretization: quantization noise, aliasing<br>• Processing, code-size efficiency<br>• Run-time efficiency, DSP, Multimedia processors, SIMD<br>• Very long instruction word (VLIW) machines, microcontrollers, Multiprocessor systems on a chip (MPSoCs),<br>• Reconfigurable logic, Field programmable gate arrays (FPGAs)<br>• Memories<br>• **Communication**<br>• Output: D/A-Converter<br>• Sampling theorem, actuators, secure hardware | Ch 3 | Homework |
| 5 | System Software | • Embedded operating systems, real-time operating systems<br>• Virtual machines<br>• Resource access protocols (Priority inversion and inheritance)<br>• Resource access protocols (Priority ceiling, stack resource policy)<br>• ERIKA, hardware abstraction layers, middleware, real-time data bases | Ch 4 | Homework<br>Quiz |
| 6 | Programming Fundamental | • What is a program?<br>• Assembly language<br>• Compilers<br>• Cross Developments | | |
| 7 | **Student Presentations** | • Presenting the assessment based on chosen topic.<br>• Each student must present in 30 minutes their topic taken from the Textbook or Internet in front of their class mate. | | |
| 8 | **MIDTERM SEMESTER BREAK** | | | |
| 9 - 10 | Evaluation and validation | • Scope, multi-objective optimization, relevant objectives<br>• performance evaluation (early estimation & worst case execution time analysis), prerequisite: integer linear programming<br>• Real Time calculus<br>• Energy and power models, thermal models<br>• Risk- and dependability analysis<br>• Simulation, rapid prototyping and emulation, formal verification (briefly) | Ch 5 | Homework |


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| 11 - 12 | Application mapping | • problem definition, classification of scheduling systems<br>• Aperiodic scheduling without precedence constraints<br>• Aperiodic scheduling with precedence constraints<br>• Periodic scheduling with precendence constraints, sporadic events<br>• Hardware/Software Partitioning<br>• Mapping of Applications to Multi-Processor Systems | Ch 6 | Homework Quiz |
| 13 | Optimizations | • task concurrency management, floating-point, high-level loop transformations<br>• SPM, allocation strategies<br>• optimizations for caches, offset assignment problem<br>• additional compiler optimizations, dynamic voltage scaling | Ch 7 | Homework |
| 14 | Test | • test pattern generation<br>• test pattern application<br>• response observation<br>• result comparison | Ch 8 | Homework & Quiz |
| 15 | **Review** | **Wrap up the whole semester course / Review the semester** | | |
| 16 -17 | **FINAL EXAMINATION** | | | |

## 7. Book Reference:

**a) Main Text Book:** "*Embbeded System Design – Embbeded Systems Foundation of Cyber-Physics Systems*", Second Edition, Author: Dr. Peter Marwedelr, Publisher Springer, **ISBN: 978-94-007-0256-1**.

b) **Supplement Textbook:**

- "***First Steps with Embedded Systems***", **By: Vyte Craft Limited**,
- "***Introduction to Embedded Systems – Cyber Physcial Systems Approach*", First Edition,** Author: **E.A. Lee and S.A. Seshia. LeeSeshia.org, 2011**, ISBN 978-0-557-70857-4


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