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## SYLLABUS

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|-----------------------|-----------------------------|
| <b>Date/ Revision</b> | 16 February 2017 / Rev.0    |
| <b>Faculty</b>        | Engineering                 |
| <b>Approval</b>       | Dean of Engineering Faculty |

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**SUBJECT :** Microcontroller and Embedded System Design

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### 1. Identification of Subject:

|                 |                                  |
|-----------------|----------------------------------|
| Name of Subject | : Electronic Devices and Circuit |
| Code of Subject | : ELEC-2300                      |
| SKS             | : 3                              |
| Semester        | : 4                              |
| Study Program   | : ELE, MTE                       |
| Lecturer        | : Dipl.-Ing. Maralo Sinaga       |

### 2. Competency

After studying the Microcontroller System and Interface course, the student able to:

- Analyse the digital logic circuit containing combinatorial- and sequential logic system;
- Explain the architecture of computer system;
- distinguish between microprocessor and microcontroller;
- Describe the architecture of MCS-51 microcontroller family;
- install and use EdSim51 software to simulate MCS51 Microcontroller family;
- write assembly language for MCS-51 microcontroller family;
- interface input- and output – devices into MCS51 microcontroller family;
- Interface various analog transducers with a MCS51 microcontroller family;
- Use hardware end-points for interfacing devices including RS232, I2C, SPI
- Use interrupts, timers, PWM, counters, and watch-dog devices in an application;
- Use inductive-load devices (such as solenoid, relays, and motors) with microcontrollers;
- Use wireless devices (HC-05 Bluetooth) devices with microcontroller;
- Install and use the Arduino IDE Software to program a Arduino microcontroller Board;
- Design an embedded system using a microcontroller.

### 3. Description of Subject:

The course provides an introduction to microcontrollers and interfacing. Operation and applications of microcontrollers, including system level organization, analysis of specific processors, and software and hardware interface design. This presents details of one or more microcontroller architectures, building on material learned in prerequisite courses. Principles of low-level program execution and interfacing to peripherals are emphasized in this course. The course prepares the student with a set of concepts common to many different embedded systems.

#### 4. Learning Approach

|              |   |
|--------------|---|
| Approach     | : Combination of Expository - inquiry and collaborative           |
| Method       | : Discussion, question answer, sample problem, group work         |
| Student Task | : Home work, presentation, Laboratory experiment                  |
| Media        | : LCD projector, Teaching Aids (components), Simulation SW, film. |

#### 5. Evaluation

|                                |              |
|--------------------------------|--------------|
| a) Absence maximum             | : < 25%      |
| b) Participation in discussion | : 5 points   |
| c) Homework, Classwork         | : 5 points   |
| d) Presentation, Simulation    | : 10 points  |
| e) 5 Weekly Quiz               | : 20 points  |
| f) Final Examination           | : 60 points  |
| Total                          | : 100 points |

#### 6. Contents/ Topics of Lecturing:

| Week | Content/ Topics of Lecturing  | Text Book Chapter   | Remark |
|------|---|---------------------|--------|
| 1    | <b>Review of Digital Electronics System</b> <ul style="list-style-type: none"> <li>Combinatorial Digital Logic</li> <li>Sequential Digital Logic:                             <ul style="list-style-type: none"> <li>Latches (SR-, RS-, D-Latch)</li> <li>Flip-Flops (SR-, D-, JK-FF)</li> <li>Applications: Counters, Timers, Registers,...</li> </ul> </li> </ul>           | Ch-1 and Supplement |        |
| 2    | <b>Computer architecture and the 8051 Microcontroller.</b> <ul style="list-style-type: none"> <li>Computer organization and architecture</li> <li>The difference between microprocessor and microcontroller</li> <li>the MCS51 Microcontroller family</li> <li>The 8051 microcontroller Hardware Structure</li> <li>Esim51 software installation and familiarizing</li> </ul> | Ch-1 and Supplement |        |
| 3    | <b>Type of Memory of the 8051 Microcontroller.</b> <ul style="list-style-type: none"> <li>Code Memory</li> <li>internal and external RAM and ROM</li> <li>Special Function Registers (SFRs)</li> <li>Bit Memory</li> <li>Basic Registers (ACC, Rn, PC, SP and DPTR)</li> <li>Exercises</li> </ul>   | Ch-2                |        |
| 4    | <b>Assembly Language Programming: Addressing Mode and Program Flows.</b> <ul style="list-style-type: none"> <li>immediate-, Direct-, indirect addressing</li> <li>External direct- and indirect-addressing</li> </ul>   | Ch-3<br>Ch-5        | Quiz-1 |

|      |   |                |        |
|------|---|----------------|--------|
|      | <ul style="list-style-type: none"> <li>• Conditional and Unconditional Branch</li> <li>• Direct Jumps and Calls</li> <li>• Return from Subroutines</li> <li>• Interrupts</li> <li>• Exercises</li> </ul>  |                |        |
| 5    | <b>Timers and I/O Programming:</b> <ul style="list-style-type: none"> <li>• How the Timer in 8051 works</li> <li>• TMOD SFRs and TCON SFRs</li> <li>• Initializing- and Reading of Timer</li> <li>• Exercises</li> </ul>  | Ch-3<br>Ch-4   | Quiz-3 |
| 6    | <b>Arithmetic and Logic Instruction</b> <ul style="list-style-type: none"> <li>• Arithmetic Instruction (ADD, ADDC, DA, SUBB, MUL, DIV)</li> <li>• Logic and Compare Instruction</li> <li>• Rotate Instruction and Data serialization</li> <li>• BCD,</li> <li>• Exercises</li> </ul>                                   |                |        |
| 7    | <b>Interfacing of 8051 microcontroller:</b> <ul style="list-style-type: none"> <li>• Interfacing into 7-Segments;</li> <li>• Interfacing into 4x3 Keypad;</li> <li>• Interfacing into LCD</li> <li>• Interfacing into sensors, ADC and DAC</li> <li>• Interfacing into external memory RAM and ROM</li> </ul> Exercises | Ch-12<br>Ch-13 |        |
| 8    | <b>MIDTERM SEMESTER BREAK</b>   |                |        |
| 9-10 | <b>Arduino Microcontroller Board</b> <ul style="list-style-type: none"> <li>• Introducing the Arduino Board</li> <li>• Installing and familiarizing the Arduino IDE</li> <li>• First Project with Arduino Uno</li> <li>• Exercises</li> </ul>   | Supplement     | Quiz-4 |
| 11   | <b>Interfacing the Arduino Uno into Keypad and 7-Segment</b> <ul style="list-style-type: none"> <li>• Connection Diagram</li> <li>• Arduino Program Code</li> <li>• Exercises</li> </ul>  | Supplement     |        |
| 12   | <b>Interfacing the Arduino Uno into Keypad and LCD:</b> <ul style="list-style-type: none"> <li>• Connection Diagram</li> <li>• Arduino Program Code</li> <li>• Exercises</li> </ul>   | Supplement     | Quiz-5 |
| 13   | <b>Interfacing the Arduino Uno into Sensor, and DC-Motor</b> <ul style="list-style-type: none"> <li>• Connection Diagram</li> <li>• Arduino Program Code</li> <li>• Exercises</li> </ul>  | Supplement     |        |
| 14   | <b>An Embedded System Project Examples</b> <ul style="list-style-type: none"> <li>• Formulation of the Problem</li> <li>• Connection Diagram</li> </ul>   | Supplement     | Quiz-6 |

|    |   |                         |        |
|----|---|-------------------------|--------|
|    | <ul style="list-style-type: none"> <li>• Arduino Program Code</li> <li>• Exercises</li> </ul>   |                         |        |
| 15 | <b>Wrap-up the course</b> <ul style="list-style-type: none"> <li>• Review of 8051 Microcontroller and Arduino</li> <li>• Exercises</li> </ul> | Supplement<br>Text Book | Quiz-5 |
| 16 | <b>FINAL EXAMINATION</b>  |                         |        |

## 7. Book Reference:

a) **Main Text Book:** “*Microcontroller and The 8051 Microcontroller and Embedded Systems Embedded Systems-2ED, 2014*”, **Authors:** Mazidi, Muhammad A and McKinlay Rollin, **Publisher:** Pearson Education, Inc, **ISBN:** 978-1-292-02657-2

b) **Supplement Textbooks:**

- “*Computer Organization and Architecture– 10<sup>th</sup> Edition, 2016*”, **Authors:** William Stallings, **Publisher:** Pearson Education, Inc, **ISBN:** 978-1-292-09685-8
- “*Arduino Cookbook, 2<sup>nd</sup>-Edition, 2013*” **Authors:** Michael Margolis, **Publisher:** O’Reilly Media, Inc, **ISBN:** 978-1-449-31387-6

c) **Others / Internet**

- [www.8052.com](http://www.8052.com)
- [www.keil.com](http://www.keil.com)
- <http://www.8051projects.net/>
- <http://www.microcontroller-project.com/>
- [www.8051project.org/](http://www.8051project.org/)
- <https://www.pjrc.com/tech/8051/>
- etc.