| **COURSE INFORMATON** | | | | |
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| **Course Code** | **EE 242** | **Course Title** | **MICROPROCESSOR SYSTEMS** | |
| *Semester* | *Credits* | *ECTS* | *C +P + L Hour* | Prerequisites |
| 4 | 4 | 6 | 3+0+2 | EE241 |

| **Language of Instruction** | | **Course Level** | **Course Type** |
| --- | --- | --- | --- |
| English | | Undergraduate | Core/Elective |
| **Course Coordinator** | Asst. Prof. Gökhan Şahin | | |
| **Instructors** | Asst. Prof. Gökhan Şahin | | |
| **Assistants** | [Çağdaş Altıntaş](mailto:cagdas.altintas@yeditepe.edu.tr) | | |
| **Goals** | The aim of this course is to provide the students with the knowledge of about microprocessor architecture and how to program them. | | |
| **Content** | * In this class, the fundamentals of embedded system hardware and firmware design will be explored. * Basics of microcontroller architecture will be introduced. * A well-known 32-bits ARM based microcontroller; STM32F407VG (SGS-Thomson Microelectronics) will be studied. * Firmware design using ‘C language’ and firmware debugging will be discussed. * Cortex Microcontroller Software Interface Standard (CMSIS) will be studied. * The HW/Firmware development tools for the microcontroller will be used effectively. * A complete embedded system design cycle will be carried out. | | |
| **Contribution of the Course to the Professional Education** | * Embedded system design tools will be understood. * The basics of microprocessor systems is studied * The student understands how a HW-SW system design carried out * Practical hands-on experience is gained to enable the students to realize their ideas/projects. | | |

| **Course Learning Outcomes** | **Detailed Program Outcomes** | **Teaching Methods** | **Assessment Methods** |
| --- | --- | --- | --- |
| Introductory understanding of microcontroller architecture 3a | | 1,3,7 | A,F,G,D |
| Data and program memory accessing and interfacing 3a | | 1,3,7 | A,F,G,D |
| Timing and synchronization, the use of interrupts 1b,2a,4b | | 1,3,7 | A,F,G,D |
| Use of internal peripherals like ADC, Timer, PWM modules. 1b,2a,4b | | 1,3,7 | A,F,G,D |
| Interfacing with on-chip and external devices, i.e. motors, timers, LEDs, switches, buttons, sensors, etc. 1b,2a,4b | | 1,3,7 | A,F,G,D |
| Practical experience to use a microcontroller 7c,5a | | 1,3,7 | A,F,G,D |
| Use of internal peripherals like ADC, Timer, PWM modules. 1b,2a,4b | | 1,3,7 | A,F,G,D |
| Interfacing with on-chip and external devices,  i.e. motors, timers, LEDs, etc. 1b,2a,4b | | 1,3,7 | A,F,G,D |
| Practical experience to use a microcontroller 7c,5a | | 1,3,7 | A,F,G,D |

| **Teaching Methods:** | 1: Lecture by instructor, 2: Lecture by instructor with class discussion, 3: Problem solving by instructor, 4: Use of simulations, 5: Problem solving assignment, 6: Reading assignment, 7: Laboratory work, 8: Term research paper, 9: Presentation by guest speaker, 10: Sample Project Review, 11: Interdisciplinary group working, 12: … |
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| **Assessment Methods:** | A: Written exam, B: Multiple-choice exam C: Take-home quiz, D: Experiment report, E: Homework, F: Project, G: Presentation by student, H: … |

| **COURSE CONTENT** | | |
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| **Week** | **Topics** | **Study Materials** |
| 1 | Common Computer Organization / Microcontroller basics  Lab1: Introduce the discovery board, Installation of Compiler/debugger, basic examples demonstrating the use of compiler/debugger | Course book / Lecture Slides |
| 2 | Common Computer Organization / Microcontroller basics  Bare metal programming via registers  Lab2: Introduce the discovery board, Installation of Compiler/debugger, basic examples demonstrating the use of compiler/debugger | Course book / Lecture Slides |
| 3 | Introduction to ARM cortex M4 processors, STM32F40x HW architecture  Lab3: Using C language on discovery board | Course book / Lecture Slides |
| 4 | IO interfacing, and STM32F407 interfaces /  Lab4: General purpose IO module and blinking LED application | Course book / Lecture Slides |
| 5 | Cmsis structures: creating them from register memory map.  Lab5: multi-7-segment display application | Course book / Lecture Slides |
| 6 | USB CDC Lab6: 7-segment display with matrix keypad application | Course book / Lecture Slides |
| 7 | SPI &interfacing accelerometer  Lab7: GP input/output experiments using CMSIS | Course book / Lecture Slides |
| 8 | Mİdterm/term project | Course book / Lecture Slides |
| 9 | Sampling, ADC module, DMA  Lab8: Read ADC, write to 7-segment | Course book / Lecture Slides |
| 10 | Interrupts, Timer interrupt, sampling  Lab9: generate a square wave with desired frequency | Course book / Lecture Slides |
| 11 | PWM applications  Lab10: Generate PWM with adjustable duty cycle. Freq.: 10 KHz. Duty cycle should be adjusted using pot. Observe PWM signal using osc. | Course book / Lecture Slides |
| 12 | Serial communication: UART  Lab 11: data transfer application between PC and STM32F407 using hyper terminal via UART connection | Course book / Lecture Slides |
| 13 | Application examples /midterm /project | Course book / Lecture Slides |
| 14 | Application examples | Course book / Lecture Slides |
| 15 | Application examples | Course book / Lecture Slides |

| **RECOMMENDED SOURCES** | |
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| **Textbook** | Geoffrey Brown, Discovering the STM32 Microcontroller, 2012  Carmine Noviello , Mastering Stm2,2022 |
| **Additional Resources** | Reference Manual, Sample Projects |

| **MATERIAL SHARING** | |
| --- | --- |
| **Documents** | Projects on github,onenote |
| **Assignments** |  |
| **Exams** |  |

| **ASSESSMENT** | | |
| --- | --- | --- |
| **IN-TERM STUDIES** | **NUMBER** | **PERCENTAGE** |
| Midterm/Project | 2 | %25 |
| Lab Experiments | 1 | %5 |
| Quiz/hw |  | **%5** |
| **Total** |  |  |
| **CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE** |  | 40 |
| **CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE** |  | 60 |
| **Total** |  | **100** |

| **COURSE CATEGORY** | Field Course |
| --- | --- |

| **COURSE'S CONTRIBUTION TO PROGRAM OUTCOMES** | | |
| --- | --- | --- |
| No | Program Learning Outcomes | check √ |
| 1a | Adequate knowledge in mathematics, science and engineering subjects pertaining to the relevant discipline, |  |
| 1b | Ability to use theoretical and applied knowledge in these areas in complex engineering problems. | √ |
| 2a | Ability to identify, formulate, and solve complex engineering problems, | √ |
| 2b | Ability to select and apply proper analysis and modeling methods for this purpose. |  |
| 3a | Ability to design a complex system, process, device or product under realistic constraints and conditions, in such a way as to meet the desired result, | √ |
| 3b | Ability to apply modern design methods for this purpose. |  |
| 4a | Ability to devise, select and use modern techniques and tools needed for analyzing and solving complex problems encountered in engineering practice. | √ |
| 4b | Ability to employ information technologies effectively. |  |
| 5a | Ability to design experiments for investigating complex engineering problems or discipline specific research questions, | √ |
| 5b | Ability to conduct experiments, gather data, analyze and interpret results for investigating complex engineering problems or discipline specific research questions. |  |
| 6a | Ability to work efficiently in intra-disciplinary teams, |  |
| 6b | Ability to work efficiently in multi-disciplinary teams, |  |
| 6c | Ability to work individually. |  |
| 7a | Ability to communicate effectively both orally and in writing, |  |
| 7b | Knowledge of a minimum of one foreign language, |  |
| 7c | Ability to write effective reports and comprehend written reports,  prepare design and production reports, | √ |
| 7d | Ability to make effective presentations, |  |
| 7e | Ability to give and receive clear and intelligible instructions. |  |
| **8a** | Recognition of the need for lifelong learning, ability to access information, ability to follow developments in science and technology, |  |
| **8b** | Ability to continue to educate him/herself. |  |
| **9a** | Consciousness to behave according to ethical principles and professional and ethical responsibility. |  |
| **9b** | Knowledge on standards used in engineering practice. |  |
| **10a** | Knowledge about business life practices such as project management, risk management, change management. |  |
| **10b** | Awareness in entrepreneurship and innovation. |  |
| **10c** | Knowledge about sustainable development. |  |
| **11a** | Knowledge about the global and social effects of engineering practices on health, environment, and safety, |  |
| **11b** | Knowledge about contemporary issues of the century reflected into the field of engineering. |  |
| **11c** | Awareness of the legal consequences of engineering solutions. |  |

| **ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION** | | | |
| --- | --- | --- | --- |
| Activities | Quantity | Duration (Hour) | Total Workload (Hour) |
| Course Duration | 14 | 3 | 42 |
| Hours for off-the-classroom study (Pre-study, practice) | 14 | 6 | 84 |
| Mid-terms/proje | 1 | 2 | 2 |
| Laboratory | 10 | 2 | 20 |
| Final examination | 1 | 4 | 4 |
| **Total Work Load** |  |  | 152 |
| **Total Work Load / 25 (h)** |  |  | 6.02 |
| **ECTS Credit of the Course** |  |  | 6 |

| Prepared by: Gökhan Şahin | Preparation date: 4/18/2022 |
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