Universidad de Navarra

Diseño de sistemas embebidos biomédicos (MIB)

Teaching guide 2025-26

PRESENTACIÓN

Breve descripción:

The course focuses on embedded devices in the healthcare sector and provides the technical and technological knowledge necessary for the design and development of innovative solutions involving multidisciplinary contexts. Throughout the course, students will engage in a series of practical exercises during which they will develop a complete system, starting with sensing and then progressing through signal conditioning, acquisition, processing, wired and wireless transmission, and display of signals originating from the human body.

- **Titulación**: Máster en Ingeniería Biomédica
- **Módulo/Materia**: Especialidad en Tecnologías, Sistemas y Dispositivos Biomédicos / Tecnologías, Sistemas y Dispositivos Biomédicos (Especialidad Análisis de Datos: Módulo Optativo/Materia Optatividad)
- **ECTS**: 5 ECTS
- **Curso, semestre**: 1º, Segundo
- **Carácter**: Obligatorio
- **Profesorado**:
  - Adam Podhorski - Email: apodhorski@unav.es / Profesor Contratado Doctor
  - Javier Díaz Dorronsoro - Email: jdiaz@tecnun.es / Profesor titular
- **Idioma**: English

RESULTADOS DE APRENDIZAJE (Competencias)

- CB6 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación
- CB7 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio
- CB9 - Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades
- CB10 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.
- CG02 - Realizar investigación, desarrollo e innovación en productos, procesos y /o métodos en ingeniería biomédica.
- CG05 - Proyectar, calcular y diseñar productos, procesos, instalaciones y sistemas de control en el área de la ingeniería biomédica.
- CE10 - Integrar tecnologías del ámbito de la ingeniería para solucionar las necesidades médicas
- CE11 - Modelar sistemas biomédicos desde distintas perspectivas tecnológicas

PROGRAMA

1. **Introduction I**

    1. Embedded systems
    2. Microprocessors and microcontrollers
    3. Rapid prototyping of circuits
    4. Embedded Systems Programming I
    5. Arduino
2. **Introduction II**
    1. Embedded Systems Programming II
    2. Connection with analog sensors
3. **Interrupts and real-time processing**
4. **Communications**
5. **SPI protocol**
6. **I2C protocol**
7. **Application development with Processing**
8. **Wireless communications**
9. **Project**

ASSESSMENT

ORDINARY CALL

- In-class activities: 5%
- Mid-term exams: 15%
- Lab reports: 30%
- Final Project: 50%

EXTRAORDINARY CALL

- Project: 50%.
- Theoretical-practical exam: 50%.

OFFICE HOURS

Dr Adam Podhorski (apodhorski@unav.es)

- Building: Ibaeta, room D22
- By appointment.

Dr Javier Díaz (jdíaz@unav.es)

- Edificio: Miramón, despacho M218
- Horario de tutoria: Monday from 15:00 to 16:00.

BIBLIOGRAPHY AND RESOURCES

Basic bibliography:

1. Arduino Language Reference: http://arduino.cc/en/Reference/HomePage.
2. Jeremy Blum, Exploring Arduino: Tools and Techniques for Engineering Wizardry, Wiley, 2013. Localízalo en la biblioteca (físico) Localízalo en la biblioteca (electrónico)
3. Book webpage: http://exploringarduino.com/.
4. Pulse sensor web page: http://pulsesensor.com/.

Additional bibliography:

1. ATmega328P microcontroler web page (includes the link to the datasheet): http://www.atmel.com/devices/atmega328p.aspx.

EDUCATIONAL ACTIVITIES

I. CLASSROOM TEACHING ACTIVITIES

1. Lectures and Q&A sessions

Lectures: Introduction, Lab 1, and Lab 2.

Q&A Sessions: Labs 3-7

2. Labs (Required)

Lab 1-7: Construction of an embedded system with a given objective. Documenting the the system.

3. One-to-one tutorials

Each student may have personal interviews with the instructor to help him/her with personal study and learning.

4. Evaluation

In-term exams to assess the knowledge of topic covered in the Labs, Project presentation.

II.PERSONAL WORK

The course is organised in a way that maximises the time the students can engage with the instructors during the construction of an embedded system, and relegate the theory necessary to construct the system to pre-Lab personal study. Most of the Labs require the understanding topics covered earlier and system construction. spent in the lab Students must understand themes covered early in the course to be able to comprehend information presented later in the course, and will have to be able to integrate material learnt throughout the course. Therefore, it is important that they do not fall behind and try to set aside regular times outside of class to work on the course material on a daily basis.

1. Students must watch the introductory videos before the Lab covering that topic. Any doubts will be solved in a in-class Q&A session before each Lab starts.
2. Students should conduct personal study using the professor's notes, notes taken in lectures and recommended books if needed.
3. Students have to prepare oral presentations in English.

Credits/hours distribution of the activities. 6 ECTS= 150 h (25 h/ECTS)

1. Lectures and Q&A sessions	1.6 ECTS	8 h	(26.7 %)
2. Labs Seminars	0.6 ECTS	15 h	(10.0 %)
3. Evaluation	0.16 ECTS	1.5 h	(2.6 %)
Total classroom activities	2.4 ECTS	59 h	(40 %)

4. On-to-one tutorials	0.04 ECTS	1 h	(0.7 %)
5. Personal work	3.6 ECTS	90 h	(60 %)
Total	6 ECTS	150 h	(110 %)

Theoretical classes (28h)

There will be 28h of theoretical classes where the students acquired the rudiments of the epigrapher being able to present, through editing systems, and contextualize, obtaining from it historical information, Roman inscriptions of content and basic difficulty. For these tasks, a space will be reserved in the final qualification of the subject space oriented to the most practical dimension -both editing and interpretation- of the work of the epigrapher.

The remote access (Zoom) to the classes is in the internal area, section "Remote access"

Before classes, students must do some readings and/or exercises. Questions that may arise from this activity will be resolved in class or through the subject forum. In the internal area of the subject, you can consult the details of the "Activities Plan" and access the subject's doubts forum.

Epigraphic excursion (5h)

There will be an epigraphic excursion during the semester of which the student must make a final report. If necessary, this activity could be replaced by a virtual visit to a museum. The day on which this activity is carried out will be communicated in advance. The memory will be delivered from the internal area of the subject.

Student's personal work

Personal study (32h)

Epigraphic excursion and realization of the Memory (5h)

Exam completion (2h)

Tutorials (non-contact)

TOTAL: 75h