People's Democratic Republic of Algeria الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي
Ministry of Higher Education and Scientific Research
اللجنة البيداغوجية الوطنية لميدان العلوم و التكنولوجيا
National Educational Committee for the field of Science and Technology

ACADEMIC MASTER HARMONIZE

UPDATE2022

Domain	Sector	Speciality
Science And Technologies	***Electronic***	***Electronics of embedded systems***

الجمهورية الجزائرية الديمقراطية الشعبيةPeople's Democratic Republic of Algeria
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National Educational Committee for the field of Science and Technology

ماستر أكاديمي
مواءمة

برنامج وطني

تحديث2022

الميدان	الفرع	التخصص
علوم و تكنولوجيا	الكترونيك	الكترونيك الانظمة المضمنة

I–Master's identity sheet

Access conditions

(Indicate the license specialties which can give access to the Master)

Sector	Harmonized Master	Access licenses to the master's degree	Ranking according to license compatibility	Coefficient assigned to the license
Electronic	Electronics of embedded systems	Electronic	**1**	**1.00**
		Telecommunications	**2**	**0.80**
		Biomedical genius	**2**	**0.80**
		Automatic	**3**	**0.70**
		Electrical engineering	**3**	**0.70**
		Electromechanics	**4**	**0.65**
		Other licenses in the ST domain	**5**	**0.60**

II – Half-yearly teaching organization sheets of the specialty

Semester 1

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.1.1 Credits: 10 Coefficients: 5	Microcontroller systems	6	3	3:00	1h30		67h30	82h30	40%	60%
	Advanced digital electronics: FPGA and VHDL	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.1.2 Credits: 8 Coefficients: 4	Advanced signal processing	4	2	1h30	1h30		45:00	55:00	40%	60%
	Digital servo systems	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.1 Credits: 9 Coefficients: 5	TP Microcontroller systems	2	1			1h30	10:30	27:30	100%	
	FPGA and VHDL lab	2	1			1h30	10:30	27:30	100%	
	TP Advanced signal processing / TPDigital servo systems	2	1			1h30	10:30	27:30	100%	
	Embedded C++ Programming	3	2	1h30		1h00	37:50	37:50	40%	60%
EU Discovery Code: UED 1.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 1.1 Credits: 1 Coefficients: 1	Technical English and Terminology	1	1	1h30			10:30	02:30		100%

Total semester 1		**30**	**17**	**1:30**	**6:00**	**5:30**	**375h00**	**375h00**		

Semester 2

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 1.2.1 Credits: 10 Coefficients: 5	Embedded Processor Architecture	6	3	3:00	1h30		67h30	82h30	40%	60%
	Signal ProcessorsDigital (DSP)	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 1.2.2 Credits: 8 Coefficients: 4	Embedded Artificial Intelligence	4	2	1h30	1h30		45:00	55:00	40%	60%
	Industrial Programmable Controllers.	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 1.2 Credits: 9 Coefficients: 5	TP Architecture of Embedded Processors	2	1			1h30	10:30	27:30	100%	
	TPSignal processorsdigital	2	1			1h30	10:30	27:30	100%	
	TPArtificial intelligence / TP Industrial programmable logic controllers	2	1			1h30	10:30	27:30	100%	
	Python/Java programming for embedded systems	3	2	1h30		1h00	37:50	37:50	40%	60%
EU Discovery Code: UED 1.2 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%

Transversal EU Code: UET 1.2 Credits: 1 Coefficients: 1	Compliance with standards and rules of ethics and integrity	1	1	1h30			10:30	02:30		100%
Total semester 2		**30**	**17**	**1:30**	**6:00**	**5:30**	**375h00**	**375h00**		

Semester 3

Teaching unit	Modules	Credits	Coefficient	Weekly hourly volume			Half-yearly Hourly Volume (15 weeks)	Additional Work in Consultation (15 weeks)	Evaluation mode	
	Titled			**Course**	**T.D.**	**TP**			**Continuous monitoring**	**Exam**
Fundamental EU Code: UEF 2.1.1 Credits: 10 Coefficients: 5	Real Time Systems	6	3	3:00	1h30		67h30	82h00	40%	60%
	Artificial Vision System	4	2	1h30	1h30		45:00	55:00	40%	60%
Fundamental EU Code: UEF 2.1.2 Credits: 8 Coefficients: 4	Embedded systems	4	2	1h30	1h30		45:00	55:00	40%	60%
	Industrial networks and communications	4	2	1h30	1h30		45:00	55:00	40%	60%
Methodological EU Code: UEM 2.1 Credits: 9 Coefficients: 5	TP Artificial Vision System	2	1			1h30	10:30	27:30	100%	
	TP Embedded systems/ TPReal Time Systems	2	1			1h30	10:30	27:30	100%	
	TP Industrial networks	2	1			1h30	10:30	27:30	100%	
	Study and implementation of projects	3	2	1h30		1h00	37:50	37:50	40%	60%

EU Discovery Code: UED 2.1 Credits: 2 Coefficients: 2	Material of your choice	1	1	1h30			10:30	02:30		100%
	Material of your choice	1	1	1h30			10:30	02:30		100%
Transversal EU Code: UET 2.1 Credits: 1 Coefficients: 1	Documentary research and dissertation design	1	1	1h30			10:30	02:30		100%
Total semester 3		**30**	**17**	**1:30**	**6:00**	**5:30**	**375h00**	**375h00**		

General guidance on the choice of discovery materials:

The subjects discovered in the Master's Subject Repository ''Electronics of Embedded Systems'' (Table above) are left to the free choice of establishments who can choose their subjects indifferently from the list presented below according to their priorities.

Materials withdetailed programs:

- RFID radio-identification
- Automation
- Automotive embedded systems
- Embedded systems operating systems
- Smart cards
- Mobile robotics
- Wireless communications
- Robotics
- Renewable energies: photovoltaic solar
- Autonomous energy systems

Other subjects left to the free choice of establishments (programs open after validation of the CPND)

- Electromagnetic compatibility
- Industrial actuators
- Zigbee sensor networks
- Information Coding and Security
- Technological innovations in mechatronics
- Processors dedicated to embedded systems
- Embedded Systems for Telecommunications
- Micro and nano embedded systems
- Verification and validation of embedded systems
- Real-time operating systems
- Embedded systems for industry
- Embedded systems for avionics
- Study of mixed signals on embedded systems
- Linux system for embedded systems
- MOCN (Numerically Controlled Machine Tool)
- Web technologies: HTML, PHP, My SQL, XML
- Java 1: UML and JAVA design (basic concepts of object-oriented)
- Java 2: Real-time Java
- Java 3: Java on Android
- Linux system for embedded systems
- Connected objects: Concept, Client, Server
- Control of the movement of mobile platforms;
- GUI with Tkinter & Raspberry PI 4;
- "Power Design for Embedded Systems » ;
- "Control of electric actuators";
- Database dedicated to embedded systems;
- Cyber-Physical Systems and Internet of Things;
- The Internet of Things;
- Implementation of finite state machines using Stateflow in the Matlab environment;
- Simulation of applications in the Proteus environment;
- Use of the C-Vivado language for FPGA circuits;
- The Internet of Things.
- Advanced artificial intelligence (Deep Learning, etc.).

Semester 4

Internship in a company or in a research laboratory culminating in a dissertation and a defense.

	VHS	coefficient	Credits
Personal work	550	09	18
Internship in a company or laboratory	100	04	06
Seminars	50	02	03
Other (Framing)	50	02	03
Total Semester 4	750	17	30

This table is given for information purposes only.

Evaluation of the End of Master Cycle Project

- Scientific value (jury assessment) /6
- Writing of the dissertation (jury assessment) /4
- Presentation and response to questions (Jury assessment) /4
- Appreciation of the supervisor /3
- Presentation of the internship report (Jury assessment) /3

III - Detailed program by subject for the S1 semester

Semester: 1
Teaching unit: UEF 1.1.1
Subject 1: Microcontroller Systems
VHS: 67h30 (Class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Goals to reach :

This subject allows students to become familiar with the different functionalities offered by microcontrollers in the real world. Indeed, the world is moving towards the aspect of artificial intelligence which requires designs involving microcontrollers as key parts to achieve industrial-scale applications recommended in particular in the embedded system. Thus, students will learn to manipulate the different input/output devices, in this case: all or nothing inputs, sensor modules, supervision screens, motors and actuators, as well as the establishment of an appropriate communication layer, both simple such as those using standardized protocols, UART, I^2C, SPI, Bluetooth, and complex protocols, namely: Modbus TCP/IP, MQTT, ESP-NOW, Zigbee. Basic learning is done with the famous "ATmega328p" microcontroller given the range of applications that can be offered to the user and which goes hand in hand with the Arduino platforms. On the other hand, it has better performance than that offered by old microcontrollers such as the "PIC-16Fxx" family, moreover, it lends itself well to accepting different types of compilers, notably C-Embedded in the user-friendly environment. called "IDE". That being said, it allows students to progress more easily in a fun way towards new generations of microcontrollers such as the ESP32 or the ARM32, thus requiring a very substantial background in advanced programming.
Additionally, Proteus® software allows for interactive in-circuit simulation of these "AVR" microcontrollers, and explicit testing of the code and circuit diagram before thinking about building the target hardware. When the application is working correctly, as it should, in simulation mode, the PCB can be designed to validate the design in question.
The application of the content of this subject will be carried out within the unit:
"UEM1.1: Microcontroller systems lab".

Recommended prerequisites:

L3 microprocessor systems, Digital electronics, Finite state machine, Basic electronics, Assembly language, C language.

Content of the material:

Chapter 1 Basic microcontroller initiation (5 weeks)

- General architecture of the AVR32/PIC32 microcontroller.
- Setting a bit, clearing a bit, checking a bit, Toggling a bit and Macros.
- AVR memory architecture (Flash, Boot section; Data memory, RAM, General Registers; EEPROM).
- C-Embedded in IDE environment

- The general structure of an Arduino program (Header, declarative section, configuration and initialization, main program and definition of subprograms)
- Basic instructions (Typedef, enum, If-Else, Switch-Case, Struct, Union)
- Applications (Drop-down menu with three buttons Up, Down, OK).
- Digital output management (flashing of LEDs using delay() and millis())
- Data display (TM1637 4-digit 7-segment, 2x16 LCD)

Chapter 2. Advanced Features of Microcontrollers (5 weeks)

- Interruptions caused by external events (Rising, falling, change).
- Analogue to digital conversion by programmed interruption.
- Timer interrupts: Timer0, Timer1 and Timer2.
- PWM generator by interruption and management of Timers (CTC mode and PWM generator).
- Examples: incremental encoder dedicated to managing a drop-down menu
- AC power dimmer with a solid state relay (SSR)
- Example: control of a servomotor with OC1A/OC1B mode for different angular resolutions.
- Example: DC motor speed variator with the L298N module.
- Use of internal EEPROM (Read, Write, Erase).
- Communication protocols in half and full-duplex interrupt mode: UART (string, byte, int, double data handling)
- I^2C bus implementation and use (DH22, DS18b20, ds3231 temperature sensor)
- The SPI protocol
- Full-duplex communication
- Single master – multiple slave architecture
- High speed communication [Hz, kHz or MHz]
- Master-slave configurations.
- Flexible protocol.
- Short distance communication.
- Initializing an SD card and storing data.

Chapter 3. High-level structured programming (5 weeks)

- Multi-task systems (pointers to functions, implementation of a finite state machine "FSM" introductory example of the management of a two-way traffic light)
- Communication with Bluetooth (HC-05) using “MIT APP-Inventor” on Android and the Nano platform with the Atmega328P microcontroller).
- The CAN bus is its applications (design of a network, example of a vehicle dashboard).
- The Modbus TCP/IP fieldbus, for example the S7-1200 station with UNO equipped with the Ethernet Shield module.

Evaluation method:

Examination: 60%, Continuous Assessment: 40%

Bibliographic references:

[1] . Arduino Workshop: A Hands-On Introduction with 65 Projects; By John Boxall; No Starch Press 2013.
[2] . C Programming for the PC the Mac and the Arduino Microcontroller System; By Peter D Minns; AuthorHouse-2013

[3] . Raspberry Pi for Arduino Users: Building IoT and Network Applications and Devices; By James R. Strickland; Apress-2018
[4] . Practical AVR Microcontrollers: Games, Gadgets, and Home Automation with the microcontroller used in the Arduino; By Alan Trevennor; Apress-2012
[5] . Advances in Smart System Technologies: Select Proceedings of ICFSST 2019; Published by P. Suresh, U. Saravanakumar, Mohammed Saleh Hussein Al Salameh; Springer Nature.
[6] . INTRENET OF THINGS WITH ARDUINO AND BOLD IOT: With Arduino and Bolt; By Ashwin Pajankar; Published by BPB Publications 2018.
[7] . Arduino: A Technical Reference: A Handbook for Technicians, Engineers, and Makers; By JM Hughes; "O'Reilly Media, Inc." 2016.
[8] . Building Arduino PLCs: The essential techniques you need to develop Arduino-based PLCs; By Pradeeka Seneviratne; Apress-2017.
[9] . Arduino Robot Bonanza; By Gordon McComb; McGraw Hill Professional-2013.

Semester: 1
Teaching unit: UEF 1.1.1
Subject 2:Advanced Digital Electronics: FPGA and VHDL
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

In this subject, students will have to study the different types of programmable circuits, as well as the different design methods, in particular programming using hardware description languages.
The application of the content of this subject is carried out at the level of the subject "UEM1.1: TP FPGA & VHDL".

Recommended prior knowledge:

Digital electronics (combinatorial and sequential).

Material content:

Chapter 1. Basic concept of programmable circuits (1 week)

- General architecture of programmable logic circuits: PAL, GAL, PLD, CPLD
- Examples of constructors and programming tools: Altera Quartus II, Xilinx ISE

Chapter 2. Programming in VHDL (5 weeks)

- History of VHDL.
- Comparison between VHDL and programming languages.
- Different descriptions of an architecture: data flow, behavioral, structural.
- Identifiers and capital sensitivity.
- Comments.
- Representation of numbers in VHDL
- General structure of a VHDL code: Library, Entity, Ports, Architecture.
- Data types: predefined, user-defined
- Operators: logical, relational, shift, concatenation
- Signal attributes: EVENT, …
- Signal, variable and constant
- Process
- component
- IF-THEN-ELSE statement
- CASE-WHEN statement
- WHEN-ELSE statement
- WITH-SELECT-WHEN statement

Chapter 3. Applications on FPGA circuits (5 weeks)

- Multiplexer
- Rocker D
- Adder
- Universal counter with actions: activation, reset, load.
- Frequency divider.
- Frequency management with buttons: selection, division
- 7 segment decoder,
- Serial display on several 7 segments.
- 8-bit arithmetic-logic unit
- 8-bit comparator

Chapter 4. Advanced Design with Finite State Machines (FSM) (4 weeks)

- Introduction: Mealy and Moore structure
- Representation of an FSM machine
- FSM Design Examples

Evaluation method:

Examination: 60%, Continuous Assessment: 40%

Bibliographic references:

[1] . Volnei A. Pedroni, "Circuit Design with VHDL," MIT Press, 2004.
[2] . Volnei A. Pedroni, "Circuit Design and Simulation with VHDL", 2nd edition, MIT Press, 2010.
[3] . Bryan Mealy, Fabrizio Tappero, "Free Range VHDL", 2018
[4] . Pong P. Chu, "FPGA prototyping by vhdl examples: Xilinx Spartan™-3 Version", John Wiley & Sons, 2008.
[5] . Jacques Weber, Sébastien Moutault, Maurice Meaudre, "The VHDL language: from language to circuit, from circuit to language", Dunod, 2007.
[6] . Christian Tavernier, "Programmable logic circuits", Dunod 1992.

Semester: 1
Teaching unit: UEF 1.1.2
Subject 3:Advanced signal processing
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

The student receives the basic notions which allow him to understand and apply signal processing methods concerning random signals and digital filters.

Recommended prior knowledge:

Knowledge of digital deterministic signal processing and probabilities is necessary to follow this subject. This knowledge is provided at the level of the third year Electronics license.

Content of the material:

Chapter 1: Reminders on digital filters (RIF and RII) (3 weeks)

- Z transform
- Structures, transfer functions, stability and implementation of digital filters (RIF and RII)
- Digital minimum phase filter
- Methods for synthesizing RIF filters and RII filters
- Multi-cadence digital filters

Chapter 2: Random signals and stochastic processes (4 weeks)

- Reminder on random processes
- Stationarity
- Power spectral density
- Adapted filter, Wiener filter
- Periodogram, correlogram, averaged periodogram, smoothed periodogram
- Notions of stochastic processes
- Stationarities in the broad and strict sense and Ergodicity
- Examples of stochastic processes (Poisson process, Gaussian process and Markovian process)
- Higher order statistics (Moments and cumulants, Polyspectra, non-Gaussian processes, non-linear treatments)
- Introduction to particle filtering

Chapter 3: Parametric spectral analysis and adaptive digital filtering (4 weeks)

- Parametric methods
- AR model (Lévinson,Yulewalker, Burg, Pisarenko, Music…)
- ARMA model
- LMS stochastic gradient algorithm
- RLS recursive least squares algorithm

Chapter 4: Time-frequency and time-scale analysis (4 weeks)

- Time-frequency duality
- Short-term Fourier transform
- Continuous, discrete and dyadic wavelets
- Multi-resolution analysis and wavelet bases
- Wigner-Ville transform
- Time-Scale Analysis.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

[1] . Mori Yvon, "Random signals and stochastic processes", Lavoisier, 2014.

[2] . N. Hermann, "Engineering probabilities: random variables and Birch simulations", 2002.

[3] . M. Kunt, "Digital Signal Processing", Dunod, Paris, 1981.

[4] . J. M Brossier, "Signal and Digital Communications, Signal Processing Collection", Hermès, Paris, 1997.

[5] . M. Bellanger, "Digital signal processing: Theory and practice", 8th edition, Dunod, 2006.

Semester: 1
Teaching unit: UEF 1.1.2
Subject 4:Digital Servo Systems
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Introduce the properties and representations of discrete-time linear dynamic systems. Give the fundamental elements of the control of linear systems represented in the form of a transfer function in*Z*. Present the different methods for synthesizing discrete-time correctors.

Recommended prior knowledge:

Temporal and frequency analysis of continuous servo systems, Graphical and state representations, Corrector synthesis.

Material content:

Chapter 1 :Study of signal sampling (5 weeks)
Z transform and modified Z transform: Shannon's theorem, zero-order and first-order blockers, properties of the Z transform, Overview of the modified Z transform and its properties,… Initial value and final value theorem of a sampled system
Sampled transfers, and recurrent equation:Discretization of a continuous transfer, Representation of discrete systems by recurrence equations, Properties, …
Overview on the tbilinear transformation of a sampled transfer: Relationship betweenthe control of continuous systems and the controlof thesampled systems (study of the stability of a system sampled by the Routh criterion, etc.).

Chapter 2 :Analysis of sampled systems in state space (5 weeks)
Discretization of the state equation of a continuous system:Relationship between the equation of state of a continuous system and that of a discrete system.
Representation and resolution of the state equation of a discrete system: Differentforms of the evolution matrix (diagonal, companion, observer, controller, observability and controllability).
Stability and precision of a discrete system: Rootsof the characteristic equation, controllable modes, observable modes from the state representation of the sampled systems, Responses of a sampled system, Examination of stability by the Jurry criterion, …
Notions of governability and observability for SISO and MIMO systems.

Chapter 3.Summary of a controller (5 weeks)
Placement of poles by state feedback and by output feedback: synthesis of simple control laws
State and output estimator: Case of inaccessible system states
Other synthesis methods: digital PID controller (1 degree of freedom structure), RST controller (2 degrees of freedom structure).

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

[1] . L. Maret, Automatic Regulation, 1987.
[2] . Dorf & Bishop, Modern Control Systems, Addison-Wesley, 1995
[3] . J. L Abatut, Sampled Linear Systems and Control, Edition Dunod

[4] . J. Ragot, M. Roesch, Exercises and Problems of Automatics, Edition Masson.
[5] . J. Mainguenaud, Automatic course Volume 3, Edition Masson.
[6] . T. J. Katsuhiko, Modern Control Engineering, 5th Edition, Prentice Hall.
[7] . H. Buhler, Sampled Settings Volume 1, Edition Dunod.
[8] . M. Rivoire, Automatic Courses Volume 2, Edition Chihab.
[9] . Th. Kailath, Linear Systems, Prentice-Hall, 1980.

Semester: 1
Teaching unit: UEM 1.1
Subject 1: Practical work on microcontroller systems
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Goals :

This material is a supplement intended particularly to support and fully understand the aforementioned material "UEF1.1.1: Microcontroller systems". Furthermore, it offers students the opportunity to manipulate the knowledge acquired through well-targeted examples in a tangible way. Additionally, it is best if the student can leverage designs based on the ATmega328P microcontroller to create reliable applications. The main goal can be to enable students to create their own applications based on the requirements imposed by the design itself.

Recommended prerequisites:
Microprocessor systems, digital electronics, FPGA, basic electronics, embedded C, Grafcet.

Main content:

TP 1: Tutorial and getting started with the IDE and Proteus environment (Basic instruction: If-Else, Switch-case, delay(), millis(), typedef, enum, struct, union).

TP 2: External interrupts with two push buttons (controlling four LEDs with shift registers in both directions).

TP 3: Implementation of a finite state machine using a simple push button to PWM control a DC motor with an H-bridge from an Analog module.

TP 4: Design and production of a power dimmer (SSR solid state relay) via the Timer1 interruption and the external interruption to detect the zero crossing signal.

TP 5: Management of a drop-down menu with three push buttons and LCD2x16 display.

TP 6: Control of a stepper motor via Timer1 in CTC “Clear Timer on Compare” mode.

TP 7:ADC interfacing with operational amplifiers and analog sensors (Manipulation of internal registers).

TP 8: Multitask management using a function pointer and the timer1 interrupt to manage the scrolling time of a group of LED diodes.

TP 9: Reading/writing data from an internal EEPROM and an external EEPROM type 24lc256 using the I^2C bus.

TP 10: Control of a DC type motor via the “HC-05” Bluetooth module using the MIT App Inventor “Android” application.

TP 11: Implementation of a PID controller dedicated to temperature regulation using the DS 18b20 sensor and a aforementioned SSR solid state relay.

TP 12: Data exchange between Arduino (Slave) UNO and ESP32 (Master) type platforms using the UART communication protocol.

TP 13: Data exchange between platforms such as Arduino (Clients) UNO and Raspberry pi 4 (Broker) using the MQTT protocol.

TP 14: Data exchange between Arduino and an S7-1200 type PLC via the Modbus TCP/IP protocol to control a Micro master 420 type speed variator.

Evaluation method:

Continuous Control: 100%

Bibliographic references:

[1] . Arduino Workshop: A Hands-On Introduction with 65 Projects; By John Boxall; No Starch Press 2013.
[2] . C Programming for the PC the Mac and the Arduino Microcontroller System; By Peter D Minns; AuthorHouse-2013
[3] . Raspberry Pi for Arduino Users: Building IoT and Network Applications and Devices; By James R. Strickland; Apress-2018
[4] . Practical AVR Microcontrollers: Games, Gadgets, and Home Automation with the microcontroller used in the Arduino; By Alan Trevennor; Apress-2012
[5] . Advances in Smart System Technologies: Select Proceedings of ICFSST 2019;
[6] . Published by P. Suresh, U. Saravanakumar, Mohammed Saleh Hussein Al Salameh; Springer Nature.
[7] . INTRENET OF THINGS WITH ARDUINO AND BOLD IOT: With Arduino and Bolt;
[8] . By Ashwin Pajankar; Published by BPB Publications 2018.
[9] . Arduino: A Technical Reference: A Handbook for Technicians, Engineers, and Makers; By JM Hughes; "O'Reilly Media, Inc." 2016.
[10] . Building Arduino PLCs: The essential techniques you need to develop Arduino-based PLCs; By Pradeeka Seneviratne; Apress-2017.
[11] . Arduino Robot Bonanza; By Gordon McComb; McGraw Hill Professional-2013
[12] . Arduino Sketch for ESP32 Development Workshop; Agus Kurniawan; Published by PE Press-2018.

Semester: 1
Teaching unit: UEM 1.1
Subject2:FPGA and VHDL lab
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

This subject is built around the subject "UEF1.1.1: Advanced digital electronics: FPGA and VHDL"; it allows students to apply the knowledge acquired in the form of specific examples.
This subject allows the student to design an electronic system using the VHDL description language and to test each design on an FPGA board.

Recommended prior knowledge:
Combinatorial and sequential logic.

Material content:

TP1: Presentation of the development and simulation tool:Altera Quartus II or Xilinx ISE.

TP2: Exploitation of the development board through a given example of an adder.

TP3: First circuit examples: multiplexer, D flip-flop.

TP4: Simple 48-bit decimal counter.

TP5:48-bit decimal counter with actions: activation, reset, charge.

TP6: Tricolor road traffic light.

TP7: Multiplier/divider with shift registers.

TP8: Serial display on several 7 segments.

TP9: Digital clock.

TP10: Frequency division.

TP11: Frequency division controllable with buttons.

TP12:VGA display.

Evaluation method:
Continuous Control: 100%

Bibliographic references:

[1] . Volnei A. Pedroni, "Circuit Design with VHDL," MIT Press, 2004.
[2] . Volnei A. Pedroni, "Circuit Design and Simulation with VHDL", 2nd edition, MIT Press, 2010.
[3] . Bryan Mealy, Fabrizio Tappero, "Free Range VHDL", 2018
[4] . Pong P. Chu, "FPGA prototyping by vhdl examples: Xilinx Spartan™-3 Version", John Wiley & Sons, 2008.

[5] . Jacques Weber, Sébastien Moutault, Maurice Meaudre, "The VHDL language: from language to circuit, from circuit to language", Dunod, 2007.

[6] . Christian Tavernier, "Programmable logic circuits", Dunod 1992.

Semester: 1
Teaching unit: UEM1.1
Subject 3:TP Advanced signal processing/TPDigital servo systems
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Practical work carried out in MATLAB to give a practical aspect to complex theoretical concepts.

Recommended prior knowledge:

Mathematics (Theory and calculation of probabilities,Complex analysis)-Deterministic signal theory,Probability and statistics.

Content of the subject:

TP Advanced signal processing

TP1: Synthesis and application of a low-pass FIR filter using the window method (Hanning, Hamming, Bessel and/or Blackman)
TP2: Synthesis and application of a low-pass IIR filter by bilinear transformation
TP3: AR and/or ARMA parametric spectral analysissound signals (example of non-signals stationary)
TP4: Elimination of 50Hz interference by the LMS gradient algorithm
TP5: Denoising of a signal using the discrete wavelet transform DWT.

TPDigital servo systems

Evaluation method:

Continuous control: 100%.

Bibliographic references:

[1] .Mori Yvon, "Random signals and stochastic processes", Lavoisier, 2014.
[2] . 2. N. Hermann, "Engineering probabilities: random variables and Birch simulations", 2002.
[3] . 3. M. Kunt, "Digital Signal Processing", Dunod, Paris, 1981.
[4] . 4. M. Bellanger, "Digital signal processing: Theory and practice", 8th edition, Dunod, 2006

Semester: 1
Teaching unit: UEM 1.1
Subject 4:Embedded C++ Programming
VHS: 37h30 (Class: 1h30, practical work: 1h00)
Credits: 3
Coefficient: 2

Teaching objectives:

C++ is one of the essential languages, it is one of the most used languages in the industry. This is explained by the power of the object language, its versatility, and its execution performance.
This subject aims to discover the language with a focus on its specific use on embedded systems. The student will be able to assimilate object concepts, discover and implement the C++ language in projects and acquire the beginnings of autonomy in this language.

Recommended prior knowledge:

Digital systems, C programming.

Material content:

Chapter 1. The C++ language - introduction (1 week)
History, comparison to other languages, use of this language in the industry, standard and version of C++ (C++98 • C++03 • C++11 • C++14 • C++17 • C++ 20), new language features

Chapter 2. Compiler (1 week)
- GCC/G++ open source compiler
- x86/ARM cross compiler
- Dynamic and static linking
- Debugging
- Makefile

Chapter 3. Types, Constants, Variables (1 week)
References and Pointers, declaration, scope, initialization, array: declaration, initialization, namespace, dynamic allocation

Chapter 4. Concept of object (2 weeks)
- From C to C++, Classes and Objects
- Protection, Access
- Instance variable, Constructor, Destructor
- Overload
- “This” operator
- UML/SysML object and modeling
- Automatic code generation

Chapter 5. Derived Classes (1 week)
- Inheritance and instantiation
- Friends
- Virtual classroom
- Multiple inheritance

Chapter 6. Operator Overloading (1 week)
- Operator Functions
- Overload
- Friend function, Friend class

Chapter 7. Flow Control (1 week)
Inputs, Outputs, Status, Overload, File management

Chapter 8. Exceptions (1 week)
Setting an Exception, Intercepting

Chapter 9. Data Structure and STL **(1 week)**
Vector, Map, List, Stack, Standard Algo
Chapter 10. Particularity of embedded C++ **(1 week)**
- Standard bookstore
- Compilation and linking
- Specific coding rules
- Virtual classroom

Chapter 11. Multithreading **(2 weeks)**
- thread_local attribute
- Thread class, Mutex class
- Semaphore vs Mutex
- Conditions, Locks, future and promise
- Operator and atomic operation

Chapter 12. Smart Pointers **(1 week)**
- Deprecation of auto_ptr
- unique_ptr,
- shared_ptr
- weak_p

Chapter 13. Principle on templates **(1 week)**
- Concept of generic programming
- Model class
- Template functions

Evaluation method:

Examination: 60%, Continuous Assessment: 40%

Bibliographic references:

[1] . Michael Barr, Anthony Massa, Programming embedded systems: in C and C++, 2nd edition, O'Reilly, 2006.
[2] . Igor Viarheichyk, Embedded Programming with Modern C++ Cookbook: Practical recipes to help you build robust and secure embedded applications on Linux, 1st Edition, Kindle Edition, ISBN-13: 978-1838821043
[3] . Arkady Miasnikov, C++ for embedded systems, Kindle Edition, 2015
[4] . Christopher Kormanyos, Real-time C++: Efficient Object-oriented and Template Microcontroller Programming, Springer-Verlag Berlin and Heidelberg GmbH & Co, 2015

Semester: 1
Teaching unit: UED 1.1
Subject 1:a choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UED 1.1
Subject 2:a choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 1
Teaching unit: UET 1.1
Matter :Technical English and terminology
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Introduce the student to technical vocabulary. Strengthen your knowledge of the language. Help him atunderstand and synthesize a technical document. Allow him to understand a conversation in English held in a scientific framework.

Recommended prior knowledge:

Basic English vocabulary and grammar

Material content:

- Written comprehension :Reading and analysis of texts relating to the specialty.

- Oral comprehension: Based on authentic popular science video documents,note taking, summary and presentation of the document.

- Oral expression: Presentation of a scientific or technical subject,development and exchange of oral messages (ideas and data), Telephone communication, Gestural expression.

- Written expression :Extraction of ideas from a scientific document, Writing a scientific message, Exchange of information in writing,writing CVs, application letters for internships or jobs.

Recommendation :It is strongly recommended that the person responsible for the subject presents and explains at the end of each session (at most) around ten technical words of the specialty in the three languages (if possible) English, French and Arabic.

Evaluation method:

Review: 100%.

Bibliographic references:

[1] . PT Danison, Practical guide to writing in English: uses and rules, practical advice, Editions d'Organization 2007
[2] . A. Chamberlain, R. Steele, Practical guide to communication: English, Didier 1992
[3] . R. Ernst, Dictionary of applied techniques and sciences: French-English, Dunod 2002.
[4] . J. Comfort, S. Hick, and A. Savage, Basic Technical English, Oxford University Press, 1980
[5] . EH Glendinning and N. Glendinning, Oxford English for Electrical and Mechanical Engineering, Oxford University Press 1995
[6] . TN Huckin, and AL Olsen, Technical writing and professional communication for nonnative speakers of English, McGraw-Hill 1991
[7] . J. Orasanu, Reading Comprehension from Research to Practice, Erlbaum Associates 1986

IV - Detailed program by subject for the S2 semester

Semester: 2
Teaching unit: UEF 1.2.1
Subject 1: Embedded Processor Architecture
VHS: 67h30 (Class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

This subject allows students to learn in less time how to exploit the ARM processor architecture widely used in embedded systems. A first part showing how to configure and work with the STM32 platform development environment. A second part presents the basics of programming and the main aspects of the official HAL (Hardware Abstraction Layer). Towards the end, a more advanced part covering aspects such as the use of a real-time operating system, advanced applications like IoT and USB.

The application of the content of this subject is carried out at the level of the subject "UEM1.2: TP Architecture of microprocessors for Embedded".

Recommended prior knowledge:

Microprocessor systems, Microcontroller systems, Embedded C/C++ programming, Digital electronics: FPGA & VHDL programming.

Material content:

Chapter 1. Introduction to ARM-Cortex processors (4 weeks)

- The different types of ARM-Cortex processor
- Architecture of ARM Cortex processors
- The registers
- Memory
- The pipeline
- Interrupts and exceptions
- The instruction set
- Performances
- Introduction to STM32 families.
- The SM32CubeIDE development environment.
- Overview of the Nucléo development board.

Chapter 3. Operation of ARM-Cortex processors (8 weeks)

- Configuring I/O ports
- Interrupt management
- UART communication
- DMA management
- Clock management
- Using Timers
- Analog to digital conversion
- Digital to analog conversion
- I²C communication
- SPI communication
- Calculation of CRC (Cyclic Redundancy Check)
- Using the Watchdog Timer

- The real time clock

Chapter 4. Advanced applications of ARM-Cortex processors (3 weeks)

- FreeRTOS
- IoT development
- USB development

Evaluation method:

Examination: 60%, Continuous Assessment: 40%

Bibliographic references:

[1] . Carmine Noviello, "Mastering STM32: A step-by-step guide to the most complete ARM Cortex-M platform, using the official STM32Cube development environment", 2nd edition, Lean Pub, 2022.

[2] . Donald Norris, "Programming With STM32: Getting Started With the Nucleo Board and C/C++", McGraw-Hill, 2018.

[3] . Yifeng Zhu, "Embedded systems with ARM Cortex-M Microcontrollers in assembly language and C", 3rd edition, E-Man Press LLC, 2017.

[4] . Joseph Yiu, "Definitive guide to ARM Cortex-M23 and Cortex-M33 processors", Elsevier, 2021.

[5] . Joseph Yiu, "The definitive guide to ARM Cortex-M0 and Cortex-M0+ Processors", 2nd edition, Elsevier, 2015.

[6] . Joseph Yiu, "The definitive guide to ARM Cortex-M3 and Cortex-M4 Processors", 3rd edition, Elsevier, 2014.

[7] . Joseph Yiu, "The definitive guide to ARM Cortex-M0", Elsevier, 2011.

[8] . Joseph Yiu, "The definitive guide to ARM Cortex-M3", 2nd edition, Elsevier, 2010.

Semester: 2
Teaching unit: UEF 1.2.1
Subject 2:Digital Signal Processors (DSP)
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Know the internal architecture of a DSP and the hardware platform integrating this DSP as well as the development environment on a DSP-based platform. At the end of this subject, the student must master the design flow and must also be able to make an algorithm-architecture match for the implementation of algorithms on a platform based on DSP processors.

Recommended prior knowledge:

Microprocessor systems. Advanced digital signal processing. Programming in assembly language and C.

Material content:

Chapter 1: Fixed-point and floating-point arithmetic (2 weeks)

General information on DSP processors, Reminders on signal digitization (sampling, quantification), number representation formats, coding of integers (positive or unsigned integers, 1's complement, 2's complement), representation of real numbers in a calculator (fixed point, floating point)

Chapter 2: Architecture of TMS320C6x DSPs (4 weeks)

Internal architecture of the C6000, the processor, memory mapping, functional units, fetch and execution packets, pipeline architecture, registers, control registers, peripherals (timers, PLL, interrupts, HPI, GPIO), serial link (multichannel buffered serial port), instruction set overview

Chapter 3: Signal processing algorithms on DSP (5 weeks)

Algorithm-architecture adequacy. Quantification problems, real-time constraints, input/output management. Presentation of addressing modes (indirect, circular, inverted). Implementation of RIF and RII filtering. Offset and circular buffers, Implementation of FFT on DSP (Inverted Addressing).

Chapter 4: Advanced DSP Memory Management Techniques (4 weeks)

Presentation of internal memories (L1 and L2 levels) and external memories (SRAM, Flash, DDRAM, etc.). Management of memory sections via the *.cmd file (organization of sections). External memory management by EMIF (External Memory InterFace). Block transfer technique. Data organization for EDMA. Settings and options for EDMA. Example of data transfer using DMA controller.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

[1] . R. Chassaing, D. Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, John Wiley & Sons, 2008.

[2] . D. Reay, Digital Signal Processing and Applications with the OMAP-L138 eXperimenter, John Wiley & Sons, 2012.

[3] . TB Welch, CHG Wright and MG Morrow, Real-Time Digital Signal Processing from MATLAB to C with TMS320C6x DSPs, CRC Press, 2012.

[4] . Steven A Tretter, Communication System Design Using DSP Algorithms, Springer 2008.

[5] . N. Dahnoun, Digital Signal Processing Implementation using the TMS320 C6000 DSP platform, Prentice Hall, 2000.

[6] . N. Kehtarnaz, N. Kim, Real Time Digital Signal Processing Based on TMS320C6000, Newnes, 2004.

[7] . N. Kehtarnaz, M. Keramat, DSP System Design using TMS320C6000, Prentice Hall, 2006.
[8] . SW Smith, The Scientist and Engineer's Guide to Digital Signal Processing.
[9] . G. Baudoin and F. Virolleau, DSPs: TMS320C54x family. Application development.
[10] . L. Correvon, DSP and Real Time: Industrial Application, Haute Ecole d'Ingénierie du Canton de Neuchâtel.
[11] . P. Laspsley, J. Bier, A. Shoham, EA Lee, DSP Fundamentals: Architecture and Features, Berkley Design Technology, Inc, 1994.
[12] . Oktay Alkin, Digital Signal Processing: A Laboratory Approach using. PC-DSP, Prentice Hall.
[13] . Digital Control Applications with the TMS320 Family: Selected Application notes, Texas Instruments, 1991.
[14] . M. Pinard, DSPs, ADSP 218X family: Principles and applications, Dunod, 2000.
[15] . B. Bouchez, Audio-digital applications of DSP: theory and practice of digital sound processing, Publitronic, 2003.
[16] . Texas Instruments, TMS320C6000 Code Composer Studio Tutorial (Rev. C), http://www.ti.com/lit/ug/spru301c/spru301c.pdf, 2000.
[17] . Texas Instruments, Code Composer Studio Development Tools v3.3 Getting Started Guide (Rev. H), http://www.ti.com/lit/ug/spru509h/spru509h.pdf, 2008.
[18] . Texas Instruments, TMS320C6000 Programmer's Guide (Rev. K), http://www.ti.com/lit/ug/spru198k/spru198k.pdf, 2011.
[19] . Texas Instruments, TMS320C6000 CPU and Instruction Set Reference Guide (Rev. G), http://www.ti.com/lit/ug/spru189g/spru189g.pdf, 2006.
[20] . Texas Instruments, TMS320C6000 Chip Support Library API Reference Guide (Rev. J), http://www.ti.com/lit/ug/spru401j/spru401j.pdf, 2004.
[21] . Texas Instruments, TMS320C1X User's Guide. July 1991.

Semester: 02
Teaching unit: UEF 1.2.2
Material3:Embedded artificial intelligence
VHS: 45h00 (Class: 1h30, Tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Allow students to become familiar with artificial intelligence (AI) techniques as well as its applications in embedded systems.

Recommended prior knowledge:

This subject requires prior knowledge of advanced numerical analysis methods, C programming, MatLab or Python.

Material content:

Chapter 1.Introduction to artificial intelligenceand embedded systems (02 weeks)

Artificial Intelligence (AI); Application areas ; Main techniques linked to artificial intelligence; Advantages and disadvantages of AI; Embedded systems ; Embedded systems and AI perspectives; Challenges of implementing artificial intelligence in embedded design.

Chapter 2. Machine and deep learning methods (05 weeks)

Supervised learning; Unsupervised learning; Semi-supervised learning; Reinforcement learning; Ensemble methods in machine learning (bagging, boosting and stacking), Neural networks (MLP, RBF, RNN, BNNs, etc.); Convolutional neural networks (CNN), deep neural networks (DCNN, VGG-16, ResNet, LSTM, GRU, ...).

Chapter 3. Machine and deep learning application(05 weeks)

Simple examples of application of machine learning algorithms (Naive-Bayes, Decsion Tree, Random forest, k-NN, K-Means, svm, PCA, Q-Learning, etc.) and deep learning in regression problems , classification, control,data partitioningand size reduction.

Applications: signal processing (audio, etc.), imaging (object detection, shape recognition, segmentation, etc.), natural language, text translation, detection, diagnosis, control, etc.

Chapter 4 Implementation of Machine and Deep Learning in Embedded Systems(03 weeks)

Basic concepts of embedded machine learning; Pruning; Mixed quantification and precision; Embedded architectures intended for machine and deep learning; Reconfigurable approaches (FPGAs), CPU approaches, and GPUs; Microcontroller approaches; Accelerator-oriented approaches; Efficient implementation of MAC (multiply–accumulate) units; Optimizations at the software level and at the hardware level; Main levels of abstractions; TinyML; Embedded cards Coral, Jetson Nano, Raspberry Pi, etc.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Biblio-webo graphic references:

[1] . Warden, P. and Situnayake, D., 2019. Tinyml: Machine learning with tensorflow lite on arduino and ultra-low-power microcontrollers. O'Reilly Media.

[2] . Paluszek, Michael, and Stephanie Thomas. MATLAB machine learning. Apress, 2016.

[3] . Raschka, S., 2015. Python machine learning. Packt publishing ltd.

[4] . Liu, YH, 2017. Python Machine Learning By Example. Packt Publishing Ltd.

[5] . Ketkar, N. and Santana, E., 2017. Deep learning with Python (Vol. 1). Berkeley: A press.

[6] . Kim, P., 2017. Matlab deep learning. With machine learning, neural networks and artificial intelligence, 130(21).

[7] . Warwick, K., 2013. Artificial intelligence: the basics. Routledge.

[8] . Gajski, DD, Abdi, S., Gerstlauer, A. and Schirner, G., 2009. Embedded system design: modeling, synthesis and verification. Springer Science & Business Media.

[9] . Arora, Mohit. Embedded system design: Introduction to SoC system architecture. Learning Bytes Publishing, 2016.

[10] . Parab, J., Shinde, SA, Shelake, VG, Kamat, RK and Naik, GM, 2008. Practical aspects of embedded system design using microcontrollers. Springer Science & Business Media.

[11] . Alippi, C., 2014. Intelligence for embedded systems (pp. 1-283). Berlin: Springer.

Semester: 2
Teaching unit: UEF1.2.2
Material4: Industrial Programmable Controllers
VHS: 45 hours (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

This course allows the student to understand the hardware and software organization of APIs, to choose an API and the associated components according to the desired application and to use a programming language adapted for the API.

Recommended prior knowledge:

Combinatorial and sequential logic, Microprocessors, Microcontrollers, Sensors, Industrial networks and communications.

Content of the material:

Chapter 1: API: Industrial Programmable Controllers (2 weeks)
Definition of an API, Internal and external architecture of an API and characteristics. Choice of API. Types of API Inputs/Outputs and their characteristics.
Chapter 2: Materialization of industrial processes using APIs (3 weeks)
Definition of an automated system. The essential parts of an automated system (PO, PC, HMI, Interfacing). Operating principle of an API and an automated order-information system. Wiring. Sensor-actuator concepts, industrial networks, etc.
Chapter 3: API Programming (5 weeks)
Introduction to Grafcet. Introduction to languages: LD, IL, FBD, SFC, SCL. Application: definition of PO-PC parts, development of the grafcet, Ladder programming. Application exercises.
Chapter 4: Process Visualization (3 weeks)
Introduction to HMI (Human Machine Interface) and SCADA systems, representation and control of processes, display of alarms, recipes, archiving, user management, etc. Application exercises.
Chapter 5: Programmable controller dedicated to safety (2 weeks)
Architecture, process and machine control, management of safety functions.

Evaluation method:

Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

[1] . Frank D. Petruzella, Programmable Logic Controllers, 4th edition, Ed. McGraw Hill 2004.
[2] . William Bolton, Industrial programmable logic controllers, Editions Dunod, l'Usine Nouvelle, 2010.
[3] . Ian G. Warnock, Programmable Controllers: Operation and Application, Prentice Hall.
[4] . Gilles Michel, Architecture and applications of industrial programmable logic controllers, Dunod.
[5] . G. Michel, Industrial Programmable Automata, Dunod, 1979.
[6] . S. Thelliez and JMToullote, Grafcet and programmed industrial logic, Eyrolles, 1980.
[7] . JC Bossy, P. Brard, P. Faugère, C. Merlaud, Grafce: its practice and its applications, Educalivre Ed. Casteilla, 1995.
[8] . Henri Ney, Elements of automation, Electrotechnical and standardization collection, Edition Nathan, 1996.
[9] . M. Diaz, Petri Nets - Fundamental Models. Treaty IC2 - Computer Science and Information Systems Series, Hermès Science 2001
[10] . A. Choquet-Geniet, Petri nets – A modeling tool, Dunod, 2006. P age | 50
[11] . P. Ladet, Tools for modeling sequential automation, Petri nets, Engineering techniques, 1990.
[12] . Siemens learning/training support, Module 041-101 TIA Portal WinCC Basic with KTP700 Basic and SIMATIC S7-1200.
[13] . IEC 61508-2 Functional safety of safety-related electrical/electronic/programmable electronic systems.

Semester: 2
Teaching unit: UEF 1.2
Subject 1: Practical Processor Architecture for Embedded Systems
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

This material is built around the material "UEF1.2.2: Microprocessor Architecture for Embedded Systems"; it allows students to apply the knowledge acquired in the form of specific examples.

Recommended prior knowledge:

Microprocessor systems, combinatorial and sequential logic, fundamental electronics, power electronics.

Material content:

TP 1: Introduction to the STM Nucleo development board

TP 2: Getting started with the SM32CubeIDE environment.

TP 3: Implementation of a simple project (flashing of an LED) on the STM Nucleo board

TP 4: Development of a project with several inputs/outputs: pushers, LEDs, etc.

TP 5: Developing a project with interruptions

TP 6: Configuration and use of Timers devices.

TP 7: Transmission and reception with USART serial communication

TP 8: Analog to digital conversion

TP 9:PWM pulse width variation

TP 10: Demonstration of DMA operation

TP 11: Digital to analog conversion

Evaluation method:
Continuous Control: 100%

Bibliographic references:

[1] . Carmine Noviello, "Mastering STM32: A step-by-step guide to the most complete ARM Cortex-M platform, using the official STM32Cube development environment", 2nd edition, Lean Pub, 2022.
[2] . Donald Norris, "Programming With STM32: Getting Started With the Nucleo Board and C/C++", McGraw-Hill, 2018.
[3] . Yifeng Zhu, "Embedded systems with ARM Cortex-M Microcontrollers in assembly language and C", 3rd edition, E-Man Press LLC, 2017.
[4] . Joseph Yiu, "Definitive guide to ARM Cortex-M23 and Cortex-M33 processors", Elsevier, 2021.
[5] . Joseph Yiu, "The definitive guide to ARM Cortex-M0 and Cortex-M0+ Processors", 2nd edition, Elsevier, 2015.
[6] . Joseph Yiu, "The definitive guide to ARM Cortex-M3 and Cortex-M4 Processors", 3rd edition, Elsevier, 2014.
[7] . Joseph Yiu, "The definitive guide to ARM Cortex-M0", Elsevier, 2011.
[8] . Joseph Yiu, "The definitive guide to ARM Cortex-M3", 2nd edition, Elsevier, 2010.

Semester: 2
Teaching unit: UEM 1.2
Subject 2: TPDigital Signal Processors (DSP)
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Put into practice the theoretical knowledge acquired during course and tutorial sessions. Familiarize the student with application programs on a DSP platform using appropriate algorithm architecture. Programs can also be run using the simulator provided with CCS.

Recommended prior knowledge:

Microprocessor systems. Advanced signal processing. Programming in assembly language and C.

Material content:

Training teams are asked to complete at least 4 practicals (or more, if possible) depending on the type of DSP platform available. Furthermore, it is permitted to add or replace some TPs from the attached list with other TPs related to the subject.

***Precision**: Any change made to this list must be reported to the CPND so that other establishments can benefit from it.*

TP1: Getting started with CCS and discovery of the DSK evaluation cardTMS320C6x
Integrated development environment "Code Composer Studio (CCS)", compilation, loading, execution and debugging of simple programs.

TP2: Acquisition, processing and restitution of audio signals with the DSKTMS320C6x
Sampling, aliasing, quantization, data transfer from/to Codec and use in scan mode or interrupt mode.

TP3: Signal generation with DSKTMS320C6x
Wave generation, sine wave, AM modulation and FM modulation.

TP4: Implementation of digital filters by the DSKTMS320C6x
IIR and RIF filters.

TP 5Implementation of the discrete and fast Fourier Transform
TFD and TFR

TP5: Using Matlab with DSKTMS320C6x
Simulations: Matlab or Simulink, automatic generation of code for the DSK using Simulink, Real Time Workshop and Code Composer Studio.

Evaluation method:

Continuous control: 100%

Bibliographic references:

[1] . R. Chassaing, D. Reay, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, John Wiley & Sons, 2008.

[2] . TB Welch, CHG Wright and MG Morrow, Real-Time Digital Signal Processing from MATLAB to C with TMS320C6x DSPs, CRC Press, 2012.

[3] . Steven A Tretter, Communication System Design Using DSP Algorithms, Springer 2008.

Semester: 02

Teaching unit:UEM 1.2
Material: TPArtificial intelligence
VHS: 10:30 p.m. (TP: 1:30 a.m.) – Once a fortnight
Credits: 2
Coefficient: 1

Teaching objectives:

Allow students to become familiar with the application of artificial intelligence (AI) techniques in embedded systems.Become familiar with ML and DL libraries namely Keras, Scikit-learn, Tensorflow, etc. under python as well as their implementation on development boards (MC, Raspberry Pi, or FPGA).

Recommended prior knowledge:
This subject requires prior knowledge of programming languages such as C, VHDL, MatLab or Python.

Material content:

TP1.Presentation of development kit, programming language (libraries, toolboxes, etc.), and databases (open sources).

TP2. Application ofmachine learning (k-NN, RF, SVM, etc.)in regression, classification, control problems,data partitioningand size reduction.

TP3. Application of deep learning (DCNN, VGG-16, etc.) inimaging (object detection, classification, etc.), natural language, text translation, anomaly detection, and diagnosis.

TP4.Examples on the Implementation of machine and deep learning in embedded systems (mapembedded Coral, Jetson Nano, Arduino, FPGA, Raspberry Pi, etc.)

Evaluation method:
Continuous control: 100%

Biblio-webo graphic references:

[1] . Warden, P. and Situnayake, D., 2019. Tinyml: Machine learning with tensorflow lite on arduino and ultra-low-power microcontrollers. O'Reilly Media.
[2] . Paluszek, Michael, and Stephanie Thomas. MATLAB machine learning. Apress, 2016.
[3] . Liu, YH, 2017. Python Machine Learning By Example. Packt Publishing Ltd.
[4] . Ketkar, N. and Santana, E., 2017. Deep learning with Python (Vol. 1). Berkeley: A press.
[5] . Kim, P., 2017. Matlab deep learning. With machine learning, neural networks and artificial intelligence, 130(21).
[6] . Gajski, DD, Abdi, S., Gerstlauer, A. and Schirner, G., 2009. Embedded system design: modeling, synthesis and verification. Springer Science & Business Media.
[7] . Arora, Mohit. Embedded system design: Introduction to SoC system architecture. Learning Bytes Publishing, 2016.
[8] . Parab, J., Shinde, SA, Shelake, VG, Kamat, RK and Naik, GM, 2008. Practical aspects of embedded system design using microcontrollers. Springer Science & Business Media.
[9] . Alippi, C., 2014. Intelligence for embedded systems (pp. 1-283). Berlin: Springer.

Semester: 02
Teaching unit:UEM 1.2
Material: TPIndustrial Programmable Controllers

VHS: 10:30 p.m. (TP: 1:30 a.m.) – Once a fortnight
Credits: 2
Coefficient: 1

Teaching objectives:

Teach the student how to install, program and use a PLC. Show him how to analyze and respect the technological and security constraints linked to the interfacing of different industrial elements with an API. Introduce them to mastering the tasks of editing and debugging programs as well as correcting detected errors.

Recommended prior knowledge:

- ✔ Microcontrollers;
- ✔ API;
- ✔ Grafcet;
- ✔ Ladder.

Content of the subject: Choose at least 5 TPs.

TP01: Getting started with the API environment: Simulation of an automated system, Review of different software. Introduction to Siemens Step7 software
TP02: Implementation of an API: Hardware Configuration. Introduction to Ladder programming (On-Off of an actuator with hold). Use of digital inputs/outputs: Use of relays, contactors, etc. (possibly make the necessary wiring).
TP03: Control of the level of a tank. Using special blocks (interrupts)
Examples of applications: Complete at least 2 practical exercises from the following list of practical exercises
TP04: Control of a pneumatic cylinder
TP05: Control of three-color traffic lights for a simple intersection
TP06: Control of a bottle filling and transfer unit
TP07: Control of an automated drill
TP08: Transfer and sorting of parts of different dimensions
TP09: Control of a stamping unit
TP10: Control of a Medicine Manufacturing Unit
TP11: Control of a Tunnel Furnace

Evaluation method:
Continuous control: 100%.

Bibliographic references:

[1] . Frank D. Petruzella, Programmable Logic Controllers, 4th edition, Ed. McGraw Hill 2004.
[2] . William Bolton, Industrial programmable logic controllers, Editions Dunod, l'Usine Nouvelle, 2010.
[3] . Ian G. Warnock, Programmable Controllers: Operation and Application, Prentice Hall.
[4] . Gilles Michel, Architecture and applications of industrial programmable logic controllers, Dunod.
[5] . G. Michel, Industrial Programmable Automata, Dunod, 1979.
[6] . S. Thelliez and JMToullote, Grafcet and programmed industrial logic, Eyrolles, 1980.
[7] . JC Bossy, P. Brard, P. Faugère, C. Merlaud, Grafce: its practice and its applications, Educalivre Ed. Casteilla, 1995.

Semester: 3
Teaching unit:UEM 1.2

Matter :Python/Java programming for embedded systems
VHS:37:50(Course:1h30, TP: 1 h) – Choose between Python or Java
Credits: 3
Coefficient: 2

Teaching objectives:

According to IEEE Python and Java are the Best Programming Languages in 2021. Python is a very popular and easy to learn programming language. It is suitable for both beginners and experts for its simplicity, readable syntax and variety of uses. It is essential in all areas: embedded, a web developer, an analyst, a data scientist or a marketing expert, etc. Java is a pure object language, it is the language most suitable for real-world programming. It is present in the software kernels of almost all current technological devices. This subject allows the student to reach an appreciable level in Java programming which allows them to deal with this aspect of modern technology.

Recommended prior knowledge:

- ✔ Programming (Pasacal/Matlab language,/C language);
- ✔ Computer Science 1, Computer Science 2, Computer Science 3;

Material content:

I) Python (Choosing between Python or Java):

Chapter 1. Install and use Python **(1 week)**
Chapter 2. Basics **(2 weeks)**
2-A.Interactive mode and script mode,
2-A-1. Python Calculator,
*2-A-2. Using the operators: +, -, *, /, //, %, and **,*
2-A-3.c Priority
2-B. Variable and data type:
2-B-1.Variable initialization,Variable modification,Compound assignment
2-B-2. Data type:(. Number, Character,String of characters)
2-B-3. Conversion(str function)
2-C. Predefined function
2-C-1. Use the math module functions (abs, max, min, pow, round, sin, sqrt, log, exp, acos, etc.)
2-C-2. print function
2-C-3. Formatted output(use format function)
2-C-4. Input function
2-C-5. Function import
2-D. Source code
2-D-1. Variable naming rule
2-D-2. Comment
Chapter 3.Conditional structures **(1 week)**
(Minimum if form, if-else form, full if-elif-else form)
The limits of the simple if condition
Comparison operators
Predicates and Booleans
The keywords and, or and not
Chapter 4.Buckles **(1 week)**
The while loop
The for loop
Nested loops
The keywords break and continue
Chapter 5.Functions **(1 week)**
Creating functions
Default Parameter Values
Signing a function

The return statement
Modules,
The import method
The import method: from … import …
Packages
Import packages
Create your own packages
Chapter 6:Lists and tuples (2 weeks)
Creating and editing lists
Defining a list, Creating lists
Insert objects into a list
Add an item to the end of the list
Insert an item into the list
Concatenating lists
Removing items from a list
The keyword del
The remove method
The list journey
The enumerate function
Creating tuples
Chapter 7:Dictionaries (2 weeks)
Creating and editing dictionaries
Create a dictionary
Delete keys from a dictionary
The route methods
Key path
Journey of values
Traversing keys and values simultaneously
Dictionaries and function parameters
Chapter 8: Objects and Classes (3 weeks)
Describe objects and classes, and use classes to model objects
Define classes with data fields and methods.
Construct an object using a constructor that invokes the initializer to create and initialize data fields.
Chapter 9: Files (2 weeks)
Relative and absolute paths
Reading and writing to a file
Opening the file
Close file
Read the entire file
Writing to a file
Write other types of data
The keyword with
Save objects to files
Save an object to a file

II) Java (Choosing between Python or Java):

Chapter 1: Introduction to Java (1 week)
Chapter 2: Control instructions (3 weeks)
A) Choice instructions: The if (The simple if,*THE*if with else part, nested ifs and if-else if), 2.4 Logical operators, The switch statement, Conditional operators, 2.7 Precedence and associativity of operators
B)Buckles
2.9 The while loop
2.10 The do...while loop
2.11 The for loop
2.12 Nested loops

2.13 The break and continue keywords
The break statement
The break statement with label
Instruction continues
Instruction continues with label

Chapter 3: Math Function, Characters and Character Strings (3 weeks)

3.2 Commonly used mathematical functions
3.2.1 Trigonometric methods
3.2.2 Exponent methods (Exponentials and powers)
3.2.3 Rounding methods
3.2.4 The min, max and abs methods
3.2.5 The random method
3.3 Character data type and operations
3.4 The String type
3.4.1 Obtaining the length of a string
3.4.2 Getting characters from a string
3.4.3 Concatenation of character strings
3.4.4 Conversion of character strings
3.4.5 Reading a channel from the keyboard
3.4.6 Reading a character from the keyboard
3.5 Formatted output on screen (System.out.printf instruction)

Chapter 4: Methods (2 weeks)

4.2 Definition of a method
4.3 Calling a method
4.4 Void methods and methods allowing a value return
4.5 Passing parameters by values
4.6 Scope of variables
4.7 Method overloading

Chapter 5: Tables (3 weeks)

A) One-dimensional arrays
5.2 Basics of tables
5.2.1 Declaration of tables
5.2.2 Creating tables
5.2.3 Table size and default values
5.2.4 Access to array elements
5.2.5 Array initializers
5.2.6 foreach loop
5.3 Passing arrays to methods
5.4 Returning an array from a method
5.5 Variable-length argument lists
B) Two-dimensional arrays
5.7 Basics of two-dimensional arrays
5.7.1 Declaration and creation of two-dimensional arrays
5.7.2 Obtaining lengths of two-dimensional arrays
5.7.3 Jagged (jagged) tables
C) Multidimensional arrays

Chapter 6: Objects and Classes (3 weeks)

6.2 Defining classes for objects
6.3 Example: Definition of classes and creation of objects
6.4 Building objects using constructors
6.5 Access to objects via reference variables
6.5.1 Reference variables and reference types
6.5.2 Access to data and methods of an object
6.6 Static variables, constants and static methods

Evaluation method:

Continuous monitoring: …40%; Examination: 60%.

Bibliographic references:

[1] . Allen B. Downey Think Python: How to Think Like a Computer Scientist, O'Reilly Media, 2015;
[2] . Zed A. Shaw Learn Python 3 the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Addison-Wesley Professional, 2017;
[3] . Barry, P. Head first Python: A brain-friendly guide. "O'Reilly Media, Inc.", 2016;
[4] . Ramalho, L.. Fluent Python. "O'Reilly Media, Inc.", 2022;
[5] . Swinnen, G.. Learn to program with Python 3. Editions Eyrolles, 2012;
[6] . Le Goff, V.. Learn to program in Python. Editions Eyrolles, 2019;
[7] . Matthes, E. Python crash course: A hands-on, project-based introduction to programming. no starch press, 2019;
[8] . Harvey Deitel,Java: How to Program, 9th Edition,Prentice Hall.;
[9] . Robert Sedgewick and Kevin Wayne, Introduction to Programming in Java: An Interdisciplinary Approach, Addison Wesley, 2007;
[10] . Claude Delannoy, Programming in Java, Editions Eyrolles;
[11] . J. Hunter, Java servlets, O'Reilly;
[12] . P. Niemeyer, J. Knudsen, Introduction to Java, Ed. O'Reilly

Semester: 2
Teaching unit: UED 1.2
Subject 1:a choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UED 1.2
Subject 2:a choice
VHS: 10:30 p.m. (class: 1h30)
Credits: 1
Coefficient: 1

Semester: 2
Teaching unit: UET 1.2
Subject: Respect forstandards and rules of ethics and integrity.
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Develop students' awareness of respect for ethical principles and the rules that govern life at university and in the world of work. Raise awareness about respecting and valuing intellectual property. Explain to them the risks of moral evils such as corruption and how to combat them, alert them to the ethical issues raised by new technologies and sustainable development.

Recommended prior knowledge:

Ethics and professional conduct (the foundations)

Content of the material:

A.The respect of the rulesethics and integrity,

1. **Reminder on the MESRS Charter of Ethics and Professional Conduct:**Integrity and honesty. Academic freedom. Mutual respect. Requirement for scientific truth, objectivity and critical thinking. Equity.Rights andobligationsof the student,the teacher, administrative and technical staff,

2. Integrity and responsible research

- Respect for ethical principles in teaching and research
- Responsibilities in teamwork: Professional equality of treatment. Conduct against discrimination. The search for the general interest. Inappropriate conduct in the context of collective work
- Adopt responsible conduct and combat abuses: Adopt responsible conduct in research. Scientific fraud. Conduct against fraud. Plagiarism (definition of plagiarism, different forms of plagiarism, procedures to avoid unintentional plagiarism, detection of plagiarism, sanctions against plagiarists, etc.). Falsification and fabrication of data.

3. Ethics and professional conduct in the world of work:

Legal confidentiality in business. Loyalty to the company. Responsibility within the company, Conflicts of interest. Integrity (corruption in the workplace, its forms, its consequences, methods of combating and sanctions against corruption)

B- Intellectual property

I- Fundamentals of intellectual property

1- Industrial property. Literary and artistic property.

2- Rules for citing references (books, scientific articles, communications in a congress, theses, dissertations, etc.)

II- Copyright

1. Copyright in the digital environment

Introduction. Copyrightdatabases, software copyright.Specific case of free software.

2. Copyright in the Internet and e-commerce

Domain name law. Intellectual property on the internet. E-commerce site law. Intellectual property and social networks.

3. Patent

Definition. Rightsin a patent. Usefulness of a patent. Therepatentability. Patent applicationin Algeria and around the world.

III- Protection and valorization of intellectual property

How to protect intellectual property. Violation of rights and legal tool. Vvaluation of intellectual property. Protection of intellectual propertyin Algeria.

C. Ethics, sustainable development and new technologies

Link between ethics and sustainable development, energy saving, bioethics and new technologies (artificial intelligence, scientific progress,Humanoids, Robots, drones,

Evaluation method:

Review: 100%

Bibliographic references:

[1] . The website of the World Intellectual Property Organizationwww.wipo.int

[2] . Charter of university ethics and professional conduct,https://www.mesrs.dz/documents/12221/26200/Charte+fran__ais+d__f.pdf/50d6de61-aabd-4829-84b3-8302b790bdce

[3] . Orders No. 933 of July 28, 2016 setting the rules relating to the prevention and fight against plagiarism

[4] . The ABCs of Copyright, United Nations Educational, Scientific and Cultural Organization (UNESCO)

[5] . E. Prairat, On teaching ethics. Paris, PUF, 2009.

[6] . Racine L., Legault GA, Bégin, L., Ethics and engineering, Montreal, McGraw Hill, 1991.

[7] . Siroux, D., Deontology: Dictionary of Ethics and Moral Philosophy, Paris, Quadrige, 2004, p. 474-477.

[8] . Medina Y., Ethics, what will change in the company, Editions d'Organisation, 2003.

[9] . Didier Ch., Thinking about the ethics of engineers, Presses Universitaires de France, 2008.

[10] . Gavarini L. and Ottavi D., Editorial. of professional ethics in training and research, Research and training, 52 | 2006, 5-11.

[11] . Caré C., Morality, ethics, deontology. Administration and education, 2nd quarter 2002, n°94.

[12] . Jacquet-Francillon, François. Concept: professional ethics. The telemaque, May 2000, n° 17

[13] . Carr, D. Professionalism and Ethics in Teaching. New York, NY Routledge. 2000.

[14] . Galloux, JC, Industrial property law. Dalloz 2003.

[15] . Wagret F. and JM., Patent of invention, trademarks and industrial property. PUF 2001

[16] . Dekermadec, Y., Innovating through patents: a revolution with the internet. INSEP 1999

[17] . AEUTBM. The engineer at the heart of innovation. Belfort-Montbéliard University of Technology

[18] . Fanny Rinck and Léda Mansour, literacy in the digital age: copying and pasting among students, University of Grenoble 3 and University of Paris-Ouest Nanterre la Défense Nanterre, France

[19] . Didier DUGUEST IEMN, Cite your sources, IAE Nantes 2008

[20] . Similarity detection software: a solution to electronic plagiarism? Report of the Working Group on Electronic Plagiarism presented to the CREPUQ Subcommittee on Pedagogy and ICT

[21] . Emanuela Chiriac, Monique Filiatrault and André Régimbald, Student guide: intellectual integrity plagiarism, cheating and fraud… avoiding them and, above all, how to properly cite your sources, 2014.

[22] . Publication of the University of Montreal, Plagiarism prevention strategies, Integrity, fraud and plagiarism, 2010.

[23] . Pierrick Malissard, Intellectual property: origin and evolution, 2010.

[24] . http://www.app.asso.fr/

[25] . http://ressources.univ-rennes2.fr/propriete-intellectuelle/cours-2-54.html

V - Detailed program by subject for the S3 semester

Semester: 3
Teaching unit: UEF 2.1.1
Subject 1:Real-time systems
VHS: 67h30 (Class: 3h00, tutorial: 1h30)
Credits: 6
Coefficient: 3

Teaching objectives:

Present the architecture of a real-time operating system and programming techniques in a real-time language.

Recommended prior knowledge:

- ✔ Design of microprocessor systems;
- ✔ Computer programming;

Content of the material:

Chapter 1: General, concept and terminologies on operating systems (01 weeks)
- Reminders on the architecture of a computer.
- The operating system (definition, role, structure etc.)
- Notions of instruction and Macro-instruction
- Program, Process, Function…

Chapter 2: Introduction to real-time systems (01 weeks)
- Definition of a real-time system
- Real-time constraints. Specifications
- Classification of real-time systems.
- Characteristics and Structure of a control system.

Chapter 3: Scheduling in classic operating systems (02 weeks)
- Concept of processes and process states
- Process operation
- Process scheduling criteria
- Scheduling algorithm FCFS, SJF, SRTF & Round Robin

Chapter 4: Ofunding inreal time (04 weeks)
- Concept of real-time tasks. Modeling and characterization of tasks.
- Scheduling independent tasks
- Scheduling dependent tasks
- Scheduling in overload situation

Chapter 5: Schedulinginmultiprocessor real-time (02 weeks)
- Position and formulation of the problem
- Comparison with uniprocessor scheduling
- Multiprocessor scheduling anomalies
- Schedulability conditions
- The Earliest Deadline and Least Laxity algorithms

Chapter 6: Memory and communication management (03 weeks)
- Management of virtual memory and physical memory (paging, addressing, allocation, etc.)
- problems of competition, cooperation, synchronization

- Semaphore, monitors, …
- Inter-task communication and messages

Chapter 7: Programming **(02 weeks)**

- Introduction to Concurrent Programming
- Management of multitasking aspects, Mutual exclusion, Synchronization, Communication… Real-time programming (real-time JAVA, ADA)
- Application examples.

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

[1] . T. Shanley and D. Anderson, PCI System Architecture, Adisson-Wessley.
[2] . H. Son Sang, Advances in Real-Time Systems, Prentice Hall.
[3] . J. W. S. Liu, Real-Time Systems, Prentice Hall, 2000.
[4] . D. Abbott, Linux for embedded and Real-Time systems, 2003, Architectural Press.
[5] . Nicolas Navet, Real-time systems: Scheduling, networks and quality of service, Hermès – Lavoisier, Volume 2, 2006.
[6] . Alan C. Shaw, Real-time systems and software, John Willey & Sons, Inc., 2001.
[7] . Francis Cottet and Emmanuel Grolleau, Real-Time Control-Command System, Dunod 2005.
[8] . Nimal Nissanke, Real-Time Systems, Prentice Hall.
[9] . G.Bollela et al., The Real-Time Specification for Java, Ed. Addison-Wesley.
[10] . Cottet Francis, Joèlle Delacroix,Real-time scheduling: Courses and corrected exercises,Hermès Science Publications, 2000.
[11] . A. Darseoil, P. Pillot, Real Time in an Industrial Environment, Dunod 1991.
[12] . Y. Trinquet, J.-P. Elloy, Real-Time Executives, Engineering Techniques.

Semester: 3
Teaching unit: UEF 2.1.1
Subject 2: Artificial vision system
VHS: 45 hours (Class: 1:30, TD: 1:30)
Credits:4
Coefficient:2

Teaching objectives:

Know the main components of an artificial vision system as well as the role of each component in its design. Study the tools allowing the automatic reproduction of tasks carried out by the human visual system and interpreted by the brain.

Recommended prior knowledge:

- ✔ Signal processing ;
- ✔ Image processing.

Content of the material:

Chapter 1. Image acquisition and digitization (02 weeks)
Functional composition of an artificial vision system, Image definition, Image sensors, image digitization,Human vision,3D modeling and camera calibration.

Chapter 2.Image processing reminders (02 weeks)
One-off operations (Logarithmic transformation, Contrast inversion, histogram modification), Local operations (spatial filtering, frequency filtering)

Chapter 3. Contours and segmentation (03 weeks)
Contour detection (Definition of an contour, gradient approach, Lapalucian approach, Canny filtering, LOG filtering, active contours) Segmentation (Histogram thresholding, Region approaches)

Chapter 4. Movement (02 weeks) Motion estimation, optical flow, Horn & Schunk method, Block matching Gunnar Farneback approach

Chapter 5. Feature Detection (02 weeks)
Definition of a point of interest, geometric transformations, Moravec detector Harris detector, SIFT
Chapter 6. Machine learning (03 weeks)
Definition of machine learning, supervised classification (K-PPV, Naive bayes, SVM), unsupervised classification (K-Means, Fuzzy C-Means)

MBevaluation:
Continuous monitoring: 40%; Examination: 60%.

Bibliographic references:

*[1] .R. Gonzalez,*Digital Image Processing, Upper Saddle River, NJ, Prentice Hall, 2002 (*ISBN978-0-201-18075-6).*
*[2] . Mr.Bergounioux,*Introduction to mathematical image processing: deterministic methods*, flight. 76, Berlin, Heidelberg, Springer Berlin Heidelberg, coll. "Mathematics and Applications", March 19, 2015*
[3] . A. Herbulot, Non-parametric statistical measures for image and video segmentation and minimization by active contours, Doctoral thesis defended at the University of Nice - Sophia Antipolis, October 10, 2007
[4] . C.Grava, Motion compensation by cellular neural networks: Application in medical imaging, Doctoral thesis, defended at INSA Lyon 2003.

[5] . JP. Cocquerez and S. Phillip, Preface H.Maitre Image analysis: Filtering and segmentation, Edition Masson, 1995

[6] . HP Moravec, "Towards Automatic Visual Obstacle Avoidance". In Proceeding of Fifth International Joint Conference on Artificial Intelligence, Cambridge Massachusetts USA, pp. 584-587, 1977.

[7] . C. Harris and M. Stephens. A combined corner and edge detector. In Proceedings of The Fourth Alvey Vision Conference, pages 147

[8] . D.Lowe, Object recognition from local scale invariant features. In Proceedings of The IEEE international conference on computer vision, 1999

[9] . I. Rish, "An empirical study of the naive Bayes classifier". IJCAI Workshop on Empirical Methods in Artificial Intelligence

[10] . V.Vapnik, "Support Vector Regression Machines".Advances in Neural Information Processing Systems 9,NIPS1996, 155-161,MIT Press. 1997

[11] . E. Lebarbier, T. Mary-Huard, Course notes, Unsupervised classification, AgroParisTech, 2017

Semester: 3
Teaching unit: UEF2.1.2
Subject 1:Embedded systems
VHS: 45:00. (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

In this subject, students will be able to specify and produce an application or embedded system on a Windows basis.

Recommended prior knowledge:

The content of this subject assumes mastery of programming techniques as well as an average knowledge of a Windows or Unix type operating system and their network layers.

- ✔ Microcontrollers and Microprocessors
- ✔ Algorithmic;
- ✔ ASM, C/C++ programming, etc.
- ✔ Basic concept of operating systems
- ✔ Integrated development software (Proteus Tool suite, Mplab, CCS)

Material content:

Chapter 1. Introduction toembedded systems **(2 weeks)**

1.1. History of embedded systems
1.2. Definition of embedded systems
1.3. Development of embedded systems
1.4. Characteristics of embedded systems
1.5. Some properties of embedded systems
1.6. Design constraints of an embedded system
1.7. Some examples of embedded systems
1.8. Application areas of embedded systems:
1.9. Embedded challenges:

Chapter 2. Embedded Systems Architecture **(4 weeks)**

2.Hardware aspect of an embedded system
2.2 Von Neumann architecture
2.3 Architecture of Harvard
2.4 The microcontroller and its internal structure
2.5 The structure of an assembly program for PIC
2.6 Managing PIC16F84 interrupts
2.7 Managing the internal timers of the PIC16F84
(Timing and pulse counts)
2.8 Practical example of an embedded system based on a microcontroller

Chapter 3. Languages ofProgramming forembedded systems**(3 weeks)**

4.1 Basic Rulesof the CCS C-PCW compiler
4.2 Variables and constants
4.3 C-CCS language operators
4.4 Repetitive structures.
4.5 C-CCS functions adapted to microcontrollers
4.6 I/O management

4.7 Timer management
4.8 Management of interruptions
4.9 Serial link management
4.10 Examples

Chapter 4. Operating system for embedded and multitasking **(4 weeks)**

5.Introduction
5.2 State machine
5.3 Concepts of real-time embedded operating systems (RTOS)
5.3.1 The scheduler
5.3.2 RTOS services
5.3.3 Synchronization and message transmission tools
5.3.4 application example

Chapter 5. Case study: development of an embedded application such as the implementation of a PID corrector for temperature regulation**(2 weeks)**

Evaluation method:

Continuous monitoring: 40%; Exam: 60%.

Bibliographic references:

[1] . http://beru.univ-brest.fr/~singhoff/supports.html
[2] . Tim Wilmshurst., Designing Embedded Systems with PIC Microcontrollers: Principles and applications.
[3] . Christian Tavernier, AVR microcontrollers: from ATtiny to ATmega - Description and implementation
[4] . Christian Tavernier, Pic 18 Microcontrollers - Description and Implementation
[5] . Alexandre Nketsa; Programmable logic circuits: PLD, CPLD and FPGA memories, industrial computing
[6] . A. Dorseuil and P. Pillot. Real time in an industrial environment. DUNOD Edition, Industrial Computer Collection, 1991.
[7] . Ch. Bonnet, I. Demeure, Introduction to real-time systems, HERMES Edition
[8] . Ivan Cibrario Bertolotti_ Gabriele Manduchi-Real-Time Embedded Systems_Open-Source Operating Systems Perspective-CRC Press (2012).
[9] . Eugenio Villar, Maite Veiga (auth.), Juan Carlos LÃ³pez, RomÃ¡n Hermida, Walter Geisselhardt (eds.)-Advanced Techniques for Embedded Systems Design and Test-Springer US (1998)
[10] . Distributed Systems—Concepts and Design, 2nd Ed. Addison-Wesley Publishers Ltd., 1994.
[11] . I. Demeure and C. Bonnet. Introduction to real-time systems. Telecommunications educational collection, Hermès, September 1999.
[12] . PIC Microcontroller and Embedded Systems By Muhammad Ali Mazidi
[13] . C Programming Language by Kernighan & Ritchie PDF
[14] . http://www.craslab.org
[15] . http://beru.univ-brest.fr/~singhoff/supports.html
[16] . https://www.ukonline.be/cours/embeddedsystems
[17] . https://www.techno-science.net/glossaire-definition/Systeme-entreprises-page-3.html
[18] . http://www.embedds.com/
[19] . http://www.keil.com/rtos/
[20] . http://embedded-lab.com/

Semester: 3

Teaching unit: UEF2.1.2
Subject 2:Industrial Networks and Communications
VHS: 45:00. (Class: 1h30, tutorial: 1h30)
Credits: 4
Coefficient: 2

Teaching objectives:

Allow the student to become familiar with the concepts of digital data transmission, more particularly the different types of networks existing in the industrial world. The emphasis will be placed on understanding the different topologies with their advantages and disadvantages with respect to a given industrial installation.

Recommended prior knowledge:

- ✔ Local computer networks;
- ✔ Sensors;
- ✔ Industrial programmable controllers;

Material content:

Chapter 1.General information about fieldbuses (04 weeks)
1.1-Definitions (Bus, Field, Network, Local Area Network, Industrial Local Area Network (ILN), Business Local Area Network, Some names of industrial local area networks). 1.2-Presentation of the industrial environment. 1.3-Architecture of an RLI (field networks, workshop networks, factory networks). 1.4-Characteristics of an RLI (the number of nodes, the quantity of information, the transmission time). 1.5-Characteristics of the data exchanged in an RLI (Nature of messages exchanged, Size of messages). 1.6-Role of an RLI in an industrial installation. 1.7-OSI and RLI architecture (Adaptation of the OSI model to RLIs, Characteristics of the physical layer for RLIs, Characteristics of the MAC sublayer for RLIs).

Chapter 2.: The 485 Modbus bus (02 weeks)
Reminder on the RS232 standard. The RS485 link. The Modbus protocol. Modbus addressing and framing.

Chapter 3. The busCAN (Controller Area Network) (03 weeks)
Global view of CAN. CAN OSI models. CAN data frames and characteristics. Access methods and arbitration principle. Flows. ADC hardware. Application layer services. CANopen.

Chapter 4.Profibus (03 weeks)
Overview of Profibus and characteristics. The three types of Profibus (DP, FMS and PA). Access method. Industrial Ethernet and Profinet. Flows.

Chapter 5.Overview of industrial wireless networks (03 weeks)
Technologies, protocols and architectures of wireless industrial networks (WLAN 802.11, Bluetooth, HART protocols, Wireless Profibus, Bluetooth, ZigBee, etc.). Security of industrial wireless communication networks.

Evaluation method:

Continuous monitoring: 60%; Review: 40%.

Bibliographic references:

[1] . Belgacem Jarray, Industrial Networks: Buses, Interfaces, Industrial Ethernet, Hart. Courses and corrected exercises. Ellipses, 2017.
[2] . JF Hérold, O.Guilloton and P. ANAYA, Industrial computing and networks in 20 sheets. Dunod, 2010.
[3] . Jean-Pierre Thomesse, Industrial premises networks. Eyrolles, 1994.
[4] . Pascal Vrignat, Local industrial networks - Courses and practical work. Gaëtan Morin, 1999.
[5] . Ciame, Field networks: operational safety criteria. Lavoisier, 2009.
[6] . Ciame, Field networks: Description and selection criteria. Hermes, 2001.

Semester: 3
Teaching unit: UEM2.1
Subject 1:TP Artificial vision
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Present and discuss methodologies applied to computer vision. The concepts covered and their applications must, on the one hand, prepare students for modern artificial vision tools and, on the other hand, bring them to a mastery of ideas and techniques allowing them to integrate a digital imaging system and vision in an industrial application

Recommended prior knowledge:

Signal processing, Image processing.

Material content:

TP1: introduction to using OpenCV

- Representation of images and video under OpenCV
- Color and palette treatments

TP2: Camera calibration and 3D reconstruction

TP3: Edge detection and segmentation

TP4: Motion detection and estimation

TP5: Feature detection

TP6: Object tracking

TP7: Machine Learning

Evaluation method:

Continuous control: 100%

Bibliographic references

Semester: 3
Teaching unit: UEM 2.1
Subject 2:TPEmbedded systems / TP Real-time systems
VHS: 10:30 p.m. (TP: 1:30 a.m.)
Credits: 2
Coefficient: 1

Teaching objectives:

Help students understand the practical aspects of embedded and real-time systems. Design of an embedded system dedicated to the automobile where it will be usedAnalog and digital inputs/outputs, Timer, Interrupt, ADC-DAC conversion, LCD display, 7 segments, Serial communication (RS232, etc.), WIFI communication, Bluetooth, Design of an HMI interface.

Recommended prior knowledge:

C programming, DOS commands.

Material content:

A. Embedded systems TP -Once a fortnight

Simulation/Implementation of applications using the following hardware/software pairs: FPGA/VHDL, Arduino/C, Microprocessor/Assembler, PIC/C or Assembler, DSP/C, etc.

***Application example:*VSdesign of a central locking system for an automobile**

Below is presented, as an example, the methodology applied to the design of a central locking system for an automobile. The teacher is free to choose another application.

Initial step: Develop a program which allows you to open and close, by means of an infrared or radio frequency command, the four doors of a car using the digital command with the lighting (or flashing) of red LEDs and the emission of beeps of varying durations.
Variant 1: Take into consideration the actual closing of the doors (using stops (push button).
Variant 2: Plan for the case of opening of the doors by mistake (accidental action of the infrared command) without the actual opening of the door. Automatic condemnation after a certain period.
Variant 3: Plan for the case of a poorly closed door while the car is moving. Alert the driver: beep, display on the dashboard, etc.
Variant 4: Encryption of the control signal

Lead the student to imagine a global architecture and to propose different programming techniques (interruption, polling, functions, communication (synchronous asynchronous), I/O management, display, alarm, etc.) and estimate each time the cost of the 'application.

B. Real-time systems practical work -Once a fortnight

TP 01. Know how to use basic MS-DOS commands, Write and execute a DOS batch script. Editing files and launching commands.
TP 02. Introduction to Linux commands: Process management: Create (launch), View (listing) and Stop (kill) external processes. Memory Management in Linux (Understanding Dynamic Memory Allocation, Diagnosing Some Dynamic Allocation Issues)
TP 03. Processing of a simple example (semaphore case) using one of the real-time languages.

Evaluation method:

Continuous control: 100%

Bibliographic references:

Semester: S3
Teaching unit:UEM 2.1
Subject 3:TP Industrial networks
VHS:10:30 p.m.**(TP:**1h30**)**
Credits: 2

Coefficient: 1

Teaching objectives:

At the end of this subject with the associated Course/TD subject, the student will be able to use industrial software (Step-7, Unity Pro, Studio 5000, etc.) to configure and program an industrial network (Profibus, Profinet , CAN, Modbus, etc.) containing the main communication elements including: industrial PC, HMI, PLC and input/output modules. It will also have a good overview of the different protocols included in the OSI layers of fieldbuses (access methods, frame structures, coding, etc.).

Recommended prior knowledge:

- ✔ Programmable logic controllers (PLC);
- ✔ Programming languages for PLC: Contact, Log, List, Stl, Graph (Grafcet);
- ✔ Local computer network (LAN);
- ✔ Sensors and actuators;

Material content:

TP1:PLC (Inputs/Outputs) with Step 7, TIA Portal or Unity Pro. Programming with Graph and/or Ladder and/or STL and/or Log and/or List.
TP2: Profibus with STEP 7 or TIA Portal. Master with passive slave and/or intelligent slave. Simulation and/or practice. Using a protocol analyzer to decode Profibus messages.
TP3: Profinet with STEP 7 or TIA Portal. PLC1 + PLC2 + HMI or industrial PC. Simulation and/or practice. Using a protocol analyzer to decode Profinet messages.
TP4: Serial Modbus with Unity Pro. Master + slave + Operating screen. Using a protocol analyzer to decode Modbus messages.
TP5: Modbus TCP/IP with Unity Pro. PLC1 + PLC2. Simulation and/or practice. Using a protocol analyzer to decode Modbus messages.

TP1: Implementation and implementation on RS232, RS485.
TP2: Implementation of the CAN Bus between Arduino modules.
TP3: Modbus dialogue between a master PC and slave device. Master Modbus communication from an industrial programmable controller.
TP4: Study of Profibus industrial network (based on Arduino or visit to a factory).
TP5: Data exchange via industrial Ethernet network.
TP6: Development of an industrial wireless local network.

Evaluation method:

Continuous control: 100%.

Bibliographic references:

[1] . https://www.se.com/;
[2] . https://support.industry.siemens.com/.
[3] . Belgacem Jarray, Industrial Networks: Buses, Interfaces, Industrial Ethernet, Hart. Courses and corrected exercises. Ellipses, 2017.
[4] . JF Hérold, O.Guilloton and P. ANAYA, Industrial computing and networks in 20 sheets. Dunod, 2010.
[5] . Jean-Pierre Thomesse, Industrial premises networks. Eyrolles, 1994.
[6] . Pascal Vrignat, Local industrial networks - Courses and practical work. Gaëtan Morin, 1999.

[7] . Ciame, Field networks: operational safety criteria. Lavoisier, 2009.
[8] . Ciame, Field networks: Description and selection criteria. Hermes, 2001.

Semester: 3
Teaching unit: UEM 1.3
Subject 4: Study and implementation of projects
VHS: 37h30 (Class: 1h00, TP: 1h30)
Credits: 3
Coefficient: 2

Teaching objectives:

Create an electronic card which constitutes an embedded system for a given application.
Code development and joint hardware design.

Recommended prior knowledge:

Programming, microprocessor and microcontroller systems.

Material content:

Chapter 1: Study of simulation software (3 weeks)

Getting started with a design environment (example "Proteus Design Suite"), simulation, analysis of electronic circuits and development of printed circuits

Chapter 2: Definition and management of a project (2 weeks)

Study of the project (a simple embedded system meeting the needs of a particular sector such as medical, automobile or home automation) establishment of the specifications, technical choices, cost, schedule and planning of the execution of the work, documentation, choice of components.

Chapter 3: Creation of the electronic part (3 weeks)

Chapter 4: Creation of the software part (3 weeks)

Chapter 5: Simulation and testing (2 weeks)

Chapter 6: Technical report (2 weeks)

Writing of the technical file and defense.

Evaluation method:

Continuous control: 100%; Review: 00%.

Bibliographic references:

[1] . *https://labcenter.s3.amazonaws.com/downloads/Tutorials.pdf*
[2] . https://en.wikipedia.org/wiki/Proteus_Design_Suite
[3] . http://www.coursexercises.com/PDF_Cours_Exercices_Telecharger.php?q=proteus+ares+tutorial
[4] . https://www.ele.uva.es/~jesman/BigSeti/ftp/Cajon_Desastre/Software-Manuales/EBook%20-%20Proteus%20Manual.pdf
[5] . https://www.arduino.cc/
[6] . https://www.manager-go.com/gestion-de-projet/
[7] . https://www.techno-science.net/definition/729.html
[8] . https://formation.aapq.org/etape.php
[9] . https://www.nutcache.com/fr/blog/demarche-de-projet/

Semester: 3
Teaching unit: UED 2.1
Subject 1:a choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 3
Teaching unit: UED2.1
Subject 2:a choice
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Semester: 3
Teaching unit: UET2.1
Matter :Documentary research and dissertation design
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:
Give the student the necessary tools to search for useful information to better use it in their end-of-studies project.Help them go through the different stages leading to the writing of a scientific document. Tell himthe importance of communication and itlearn to present the work carried out in a rigorous and educational manner.

Recommended prior knowledge:
Writing methodology, Presentation methodology.

Content of the subject:

Part I-: Documentary research:

Chapter I-1: Definition of the subject (02 Weeks)
- Subject title
- List of keywords relating to the subject
- Gather basic information (acquisition of specialized vocabulary,meaning of terms, linguistic definition)
- The information sought
- Take stock of your knowledge in the field

Chapter I-2:Select information sources (02 Weeks)
- Type of documents (Ldrunk, Theses, Memoirs, Periodical articles, Conference proceedings, Audiovisual documents, etc.)
- Type of resources (Libraries, Internet, etc.)
- Evaluate the quality and relevance of information sources

Chapter I-3:Locate documents (01 Week)
- Research techniques
- Search operators

Chapter I-4: To process information (02 Weeks)
- Work organization
- Starting questions
- Summary of documents retained
- Links between different parties
- Final plan of the documentary research

Chapter I-5: Presentation of the bibliography (01 Week)
- Systems for presenting a bibliography (The Harvard system, The Vancouver system, The mixed system, etc.)
- Presentation of documents.
- Citation of sources

Part II: Memory Design

Chapter II-1: Plan and stages of the dissertation (02 Weeks)

- Identify and delimit the subject (Summary)
- Problem and objectives of the dissertation
- Other useful sections (Acknowledgments, Table of abbreviations, etc.)
- The introduction (The writing of*the introduction last)*
- State of the specialized literature
- Formulation of hypotheses
- Methodology
- Results
- Discussion
- Recommendations
- conclusion and perspectives
- Table of contents
- The bibliography
- Annexes

Chapter II-2: Writing techniques and standards (02 Weeks)

- Formatting.Numbering of chapters, figures and tables.
- Cover Page
- Typography and punctuation
- Writing. Scientific language: style, grammar, syntax.
- Spelling.Improved general language skills in terms of comprehension and expression.
- Back up, secure, archive your data.

Chapter II-3:Workshop : Critical study of a manuscript **(01 Week)**

Chapter II-4: Oral presentations and defenses (01 Week)

- How to present a Poster
- How to present an oral communication.
- Defense of a dissertation

Chapter II-5: How to avoid plagiarism? **(01 Week)**

(Formulas, sentences, illustrations, graphs, data, statistics,...)

- The quote
- The paraphrase
- Indicate the complete bibliographic reference

Evaluation method:

Review: 100%

Bibliographic references:

1. *M. Griselin et al., Guide to written communication, 2nd edition, Dunod, 1999.*
2. *JL Lebrun, Practical guide to scientific writing: how to write for the international scientific reader, Les Ulis, EDP Sciences, 2007.*
3. *HAS.Mallender Tanner, ABC of technical writing: instructions for use, user manuals, online help, Dunod, 2002.*
4. *M. Greuter, Write your dissertation or internship report well, L'Etudiant, 2007.*
5. *Mr. Boeglin, reading and writing in college. From the chaos of ideas to structured text. The Student, 2005.*
6. *M. Beaud, the art of the thesis, Editions Casbah, 1999.*
7. *M. Beaud, the art of the thesis, The discovery, 2003.*
8. *M. Kalika, Master's thesis, Dunod, 2005.*

Proposal of some discovery materials

Semester:
Teaching unit: UED
Subject 1:RFID radio-identification
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Acquire sufficient technical and practical knowledge of RFID technology with a view to its implementation in projects on embedded systems.

Recommended prior knowledge:

Architecture of microprocessor systems

Material content:

- Presentation, definition and history
- Ethics, private life,
- Obstacles to the use of RFID: metallic environment, collisions,
- RFID tag classifications
- Principle of operation
- read-only or read/write?
- TTF and ITF protocols
- RFID applications
- field communication: NFC
- how NFC/RFID works
- the main characteristics
- NFC applications

Evaluation method:

Review: 100%.

Bibliographic references:

1. *D. Henrici, RFID Security and Privacy: Concepts, Protocols, and Architectures, Springer-Verlag 2008*
2. *K. Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication, 3d edition, Wiley 2010*
3. *Syed Ahson and Mohammad Ilyas, RFID Handbook: Applications, Technology, Security, and Privacy, CRC Press 2008*
4. *http://www.centrenational-rfid.com/travailnement-dun-systeme-rfid-article-17-fr-ruid-17.html*
5. *https://fr.wikipedia.org/wiki/Protocoles_de_communication_RFID*
6. *https://fr.wikipedia.org/wiki/Radio-identification*
7. *https://fr.wikipedia.org/wiki/Communication_en_champ_proche*

Semester:
Teaching unit: UED
Subject 2:Automation
VHS: 10:30 p.m. (Class: 1h30)
Credits: 1
Coefficient: 1

Teaching objectives:

Give the student all the equipment of a smart home, their operation and their uses so that they are able to size and design a home automation installation.

Recommended prior knowledge:

Microprocessor systems, Sensors,…

Contentu of the material:

Chapter 1.Comfort in buildings (1 week)
- Thermal, acoustic and visual,

Chapter 2.Concepts on the security of property and people (7 Weeks)
-Fire security, Access control, Anti-intrusion, Video surveillance, Remote surveillance, ...

Chapter 3.Technical building management and communication (7 Weeks)
- Elighting, air conditioning, heating, regulation, networks, remote management, supervision, GTB (technical building management), GTC (centralized technical management), ...

Evaluation method:

Review: 100%.

Bibliographic references:

1. *C. Locqueneux, The Guide to Home and Connected Objects, Eyrolles 2016*
2. *FX. Jeuland, The Communicating House, Eyrolles, 2008 (2nd edition)*
3. *PROMOTELEC, Communicating Habitat, Éditions Promotelec, 2006*
4. *EA Decamps, La Domotique, Presses universitaire de France, Collection "Que sais-je?" », 1988.*
5. *Mr. Al-Qutayri,Smart Home Systems, In-Teh, Croatia 2010*
6. *C. Nugent,Smart Homes and Beyond, IOS Press, Netherlands 2006*

Semester :
Teaching unit: UED
Subject 3:Automotive embedded systems
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

This subject aims to give students the necessary foundations to know how to develop and design applications of embedded electronics in the service of the automobile, which is a discipline in its own right aimed at optimally controlling the circulation and safety of vehicles. a vehicle.

Recommended prior knowledge:

Sensors and Instrumentation.

Content of the material:

Chapter 1 :Introduction to Embedded Systems

Chapter 2 :Onboard sensors

Speed and flow sensors, Acceleration sensors, Temperature sensors, Pressure sensors, Proximity sensors, Gyro sensors.

Chapter 3:On-board actuators

Hydraulic actuator, Actuator for Air Bag, Air conditioning system, Brake system.

Chapter 4:Vehicle system architecture

Electronic computer, CAN communication bus, Sensor/Actuator networks.

Chapter 5: Automotive embedded systems

On-board sensor systems, Anti-lock braking system (ABS), Anti-slip system (ASR), Electronic dynamic behavior control (ESP), Measuring the speed of rotation of the wheels (encoder) and the speed of the vehicle (Doppler effect).

Chapter 6:Typical architecture of a vehicle model manufactured in Algeria

Evaluation method:

Review: 100%

Bibliographic references:

1. *S. Daly, Automotive Air Conditioning and Climate Control Systems,Elsevier, 2006.*
2. *J. Fenton Advances in Vehicle Design,Mechanical Engineering Publications Ltd, 1999.*
3. *B. Hollembeak, Today's Technician: Automotive Electricity and Electronics Classroom and Shop Manual Pack, 5th edition, Delmar, 2010.*
4. *N. Zaman, Automotive Electronics Design Fundamentals, Springer, 2015.*
5. *G. Asch, Data acquisition: from sensor to computer, Dunod, 2003.*
6. *G. Asch et al. Data acquisition, 3rd edition, Dunod, 2011.*
7. *M. Bayart, B. Conrard, A. Chovin, M. Robert, Intelligent sensors and actuators, 2005.*
8. *P. Dassonvalle, Les Capteurs: Exercises and corrected problems, Dunod, 2005.*
9. *R. Frank, Understanding Smart Sensors (Artech House sensors library), 2nd edition.*
10. *F. Boudoin, M. Lavabre, Sensors: main uses, Edition Casteilla, 2007.*
11. *JG Webster, Measurement, Instrumentation and Sensors Handbook,Taylor & Francis Ltd*

Semester :

Teaching unit: UED
Subject 4:Embedded systems operating systems
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Allow students to know the fundamental principles of operating systems while studying their practical application in an embedded system such as Android.

Recommended prior knowledge:

Basic notions of mathematics, algorithms and programming.

Content of the material:

Chapter 1. **(4 weeks)**
General presentation of operating systems and technical elements (e.g. OS, Android, Windows and Linux)

Chapter 2. **(3 weeks)**
Process management

Chapter 3. **(3 weeks)**
Memory management

Chapter 4. **(3 weeks)**
File management

Chapter 5. **(2 weeks)**
Executable

Evaluation method:

Review: 100%

Bibliographic references:

1. *Andrew Tanenbaum, Operating Systems, Pearson Edition.*
2. *Michael Griffiths,Michel Vayssade,Operating system architecture, Hermès - Lavoisier*.
3. *P. Levis, S. Madden, J. Polastre, R. Szewczyk, K. Whitehouse, A. Woo, D. Gay, J. Hill, M. Welsh, E. Brewer TinyOS: An Operating System for Sensor Networks in Ambient Intelligence , p. 115-148, Springer, 2005.*
4. *P. Levis, D. Gay, TinyOS Programming, Cambridge University Press, 2009.*
5. *TinyOS Open Technology Alliance: http://www.cs.berkeley.edu/~culler/tinyos/alliance/overview.pdf*
6. *www.contiki-os.org/support.html*

Semester :
Teaching unit: UED
Subject 5:Smart cards
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Acquire sufficient technical knowledge of the technology, operation and use of smart cards with a view to its implementation in projects on embedded electronic systems.

Recommended prior knowledge:

Architecture of microcontroller and/or microprocessor systems.

Content of the material:

- General, History, Applications and smart card markets.
- Semiconductors for smart cards, Technologies, Wired logic components, Microcomputers.
- Cryptology and security, Principles of cryptography, Symmetric crypto systems, Asymmetric crypto systems, Zero-knowledge crypto systems, Physical and logical security of smart cards.
- Construction principles, Interconnection of components, Insertion, Connections.
- Smart card operating systems, General and basic mechanisms, Closed operating systems, Open operating systems.
- Communication by contact, Communication by radio frequencies.

Evaluation method:

Review: 100%

Bibliographic references:

1. *W. Rankl and W. Effing, Smart Card Handbook, Wiley, 2010.*
2. *C. Tavernier, Smart cards, Dunod, 2011.*

Semester :
Teaching unit: UED
Subject 6:Mobile robotics
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

This subject aims to give students the necessary foundations to know how to develop and design applications of embedded electronics in the service of mobile robotics which is a discipline in its own right aimed at mastering movement.

Recommended prior knowledge:

Mathematics, Programming.

Content of the material:

Chapter 1: Classification and Modeling of Mobile Robots (RM) (2 weeks)

Chapter 2: Sensors used in MR (3 weeks)

Chapter 3: Location of RMs (2 weeks)

Chapter 4: The representation of the environment of an RM (2 weeks)

Chapter 5: Path planning techniques (2 weeks)

Chapter 6: Navigation and SLAM techniques (2 weeks)

Chapter 7: Humanoid robots (2 weeks)

Evaluation method:

Review: 100%

Bibliographic references:

1. *R. Siegwart, IR Nourbakhch, D. Scaramuzza, Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011.*
2. *L. Jaulin, Mobile robotics, Editions ISTE, 2015.*
3. *V. Maille, C. Accard, B. Breton, Robots: learning robotics by example, Editions Ellipse, 2016.*

Semester :
Teaching unit: UED
Subject 7:Wireless communication
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Allow students to become familiar with wireless communications systems in order to use them in electronic applications of embedded systems. Among the various wireless networks, we will focus more specifically on the WIFI network of the IEEE 802.11 standard.

Recommended prior knowledge:

Basic notions of mathematics, statistics and signal processing.

Content of the material:

Chapter 1. Wireless networks **(4 weeks)**

Chapter 2. Presentation of WIFI (802.11): **(3 weeks)**
Different WIFI standards and equipment

Chapter 3. Implementation of WIFI: **(3 weeks)**
Infrastructure mode, ad hoc modeand setting up a network

Chapter 4. Encryption: **(3 weeks)**
WEP, WAP…

Chapter 5. Hacks and solutions: **(2 weeks)**
MAC address filtering, IP address definitions and firewall installation

Evaluation method:

Review: 100%

Bibliographic references:

1. *Tanenbaum, Networks, 4th edition, Prentice Hall, 2003.*
2. *R. Perfect, Telecommunications networks, Hermès science publications, 2002.*
3. *E. Hollocou, Telecommunications techniques and networks, Armand Colin, 1991.*
4. *C. Servin, Networks and telecoms, Dunod, Paris, 2006.*
5. *D. Dromard and D. Seret, Network architectures,Pearsont Editions, 2009.*
6. *P. Polin, Networks: Fundamental principles, Edition Hermès.*
7. *D. Comer, TCP/IP, architectures, protocols and applications, Editions Interéditions.*
8. *D. Present, S. Lohier, Transmissions and Networks, courses and corrected exercises, Dunod.*
9. *P. Clerc, P. Xavier, Fundamental Principles of Telecommunications, Ellipses, Paris, 1998.*
10. *D. Battu, Introduction to Telecoms: Technologies and Applications, Dunod, Paris, 2002.*
11. *P. Rolin, G. Martineau, L. Toutain, A. Leroy, Networks, fundamental principles, Hermès edition, 1997.*

Semester :
Teaching unit: UED
Subject 8:Robotics
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Introduce the student to the fundamental aspects of robotics and recent developments in the field of industrial robotics.

Recommended prior knowledge:

None.

Content of the material:

Chapter 1: General
Definitions, Constituents of a robot, Classification of robots, Characteristics of a robot, Generations of robots, Programming of robots.

Chapter 2: Degree of freedom - Architecture
Positioning of a solid in space, Connection, Mechanisms, Morphology of robots, manipulators

Chapter 3: Geometric model of a simple chain robot
Need for a model, Operational coordinates, Translation and rotation, Homogeneous transformation matrices, Obtaining the geometric model, Modified Denavit-Hartenberg parameters, Inversion of the geometric model - Paul's method, Multiple solutions - Workspace - Aspects

Chapter 4: Simplification technique
Speed and acceleration of robots, Jacobean Matrix and its usefulness, Definition of direct and inverse equations, Meaning of singularities.

Evaluation method:

Review: 100%

Bibliographic references:

1. *H. Asada, JJE Slotine, Robot Analysis and Control, a Wiley Interscience Publication, 1986.*
2. *JJ Craig, Introduction to Robotics, Mechanics and Control, Addison-Wesley, 1989.*

Semester :
Teaching unit: UED
Subject 9:Renewable energies: photovoltaic solar
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

This subject addresses notions relating to non-polluting renewable energies, photovoltaic (PV) devices, PV conversion, the manufacturing processes of a solar cell, the assemblies of PV modules, their degradation, etc. It addresses, in in addition, the auxiliary systems: the battery, the fuel cell (with hydrogen as an energy vector), the converters, etc. The subject will also be interested in the different loads to be powered, continuous or alternative, by researching all the possibilities of coupling with a PV generator, at thedescription of a global PV system, its characteristics and whereoptimization of operationof the system.

Recommended prior knowledge:

Concepts on semiconductors, radiation physics, mathematics, electronics...

Content of the material:

Chapter 1 :Renewable energies
Forms of energy, What is renewable energy, Main renewable energies, The global energy situation, …

Chapter 2 :The solar source
Solar radiation, Solar deposit, Solar energy (thermal, photovoltaic, thermodynamic)

Chapter 3: The photovoltaic source
Photovoltaic conversion, Solar cell technology, Properties of solar cells, Modeling of a photovoltaic cell (module) (electrical, thermal modeling, etc.), Conversion efficiency, form factor, etc., Different connections (series, parallel, mixed), Impact of various factors on electrical characteristics, Degradation, Protection of photovoltaic modules, Applications of photovoltaic energy (pumping, connection to the network, etc.).

Chapter 4:Photovoltaic systems
Direct connection photovoltaic generator – load, Storage (Battery), Fuel cell, Chopper, Inverter, Study of an example of a global system (hybridization), Problem of sizing a photovoltaic installation, Maximum Power Point Tracker (MPPT).

Evaluation method:

Review: 100%

Bibliographic references:

1. *A. Vapaille,Semiconductor devices and integrated circuits, Dunod, 1987.*
2. *M. Orgeret, solar cells, Masson, 1985.*
3. *A. Ricaud, Solar photopiles, Presses Polytechniques et Universitaires Romandes, 1997.*
4. *E.Lorenzo, G. Araflio, Solar Electricity - Engineering of Photovoltaic Systems.*
5. *Minano, R. Zilles, Stand alone photovoltaic Applications, JAMES & JAMES 1994.*
6. *B. Multon, Production of electrical energy by renewable sources, Engineering Techniques, Electrical Engineering Treatises, D4005/6, May 2003.*
7. *J. Nelson, The physics of solar cells, Imperial College Press.*
8. *A. Labouret, P. Cumune, Solar cells, 5th edition - The basics of photovoltaic energy, Dunod, 2010*
9. *A. Labouret, Photovoltaic solar energy, 3rd edition, Dunod, 2006.*

10. *Deambi, Suneel, Photovoltaic System Design: Procedures, Tools and Applications, CRC Press, 2016.*
11. *O. Isabella, K. Jäger, A. Smets, R. Van Swaaij, MiroZeman, Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems, UIT Cambridge Ltd, 2016.*
12. *Gottfried H. Bauer, Lecture Notes in Physics 901, Photovoltaic Solar Energy Conversion, Springer-Verlag Berlin Heidelberg, 2015.*
13. *www.pveducation.org*
14. *http://www.cythelia.fr/nos-documents/*
15. *http://www.solems.com/depots-de-couches-minces*

Semester :
Teaching unit: UED
Subject 10:Autonomous energy systems
VHS: 10:30 p.m. (Class: 1h30)
Credit: 1
Coefficient: 1

Teaching objectives:

Arouse the student's interest in renewable energies in general and in systemsenergy companies exploiting solar or wind energy in particular. Acquirethe studenta certain skill in the sizing of a wind installation orphotovoltaic.

Recommended prior knowledge:

semiconductors, radiation physics, mathematics, electronics...

Content of the material:

Chapter 1: Electrical energy production devices
Notions on energy transformations (mechanical; thermal; hydraulic, etc.), History (Volta, Oersted, Faraday, etc.), the alternator, the dynamo, the methods of producing electrical energy (hydraulic power plant, thermal power plants). Non-renewable energy sources (fossil and nuclear). Renewable energy sources.

Chapter 2: Wind energy
History, principle and structure, Characteristics and sizing, Map of wind power in Algeria, Wind farms and power, Standards, Advantages and disadvantages. Example of a wind turbine installation.

Chapter 3: Hybrid systems
Hybrid Systems (Hydrole, Principle of operation of the tidal turbine, The different types of tidal turbines and the operators, etc.)

Chapter 4: Photovoltaic solar energy
Principle of a photovoltaic installation, the solar deposit in Algeria, Technologies of photovoltaic cells, Photovoltaic modules, MPPT, Characteristics and photovoltaic connections, Standards. The inverter (role, principle, characteristics and performance). Example of a photovoltaic installation.

Chapter 5: Other renewable energy sources
Renewable energy families(solar energy, wind energy, hydraulic energy, biomass, geothermal energy). The different renewable energies in the world. Profitability.

Evaluation method:

Review: 100%

Bibliographic references:

1. *J. Vernier,Renewable energies, PUF edition, 2012*
2. *E. Riolet, Mini-wind power, editionEyrolles, 2010*
3. *A. Labouret and M. Villoz, Photovoltaic solar energy, Editions du Moniteur 2009*
4. *B. Fox, Wind electrical energy: Production, forecasting and network integration, Technical and Engineering Collection, Dunod/L'Usine Nouvelle 2015 (2nd edition)*
5. *A. Damien, Biomass energy: Definitions, resources and methods of transformation, Technical and Engineering Collection, Dunod/L'Usine Nouvelle 2013 (2nd edition)*
6. *A. Labouret, M. Villoz, Photovoltaic installations: Design and sizing of installations connected to the network, Technical and Engineering Collection, Dunod/Le Moniteur 2012 (5^{e}editing)*

7. *http://www.cder.dz/spip.php?article1442*

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

University.....
Faculty..... ..
Department.....

Sector :.....
Speciality :.....
Academic year 20.... /20....

THE...../...../20....

MINUTES CONCERNING THE CHOICE OF DISCOVERY MATERIALS FOR THE FIRST YEAR MASTER

The undersigned teachers, after deliberation, have decided on the choice of discovery subjects for the master… proposed in the outline of this master. In this regard, the teachers* whose names follow undertake to ensure the teaching of these subjects. In the event that the training team chooses a subject whose program is not available in the framework, the person in charge of the sector undertakes to send this program to the CPND-ST for enrichment and validation.

* For each subject, it is possible to indicate the name of the main teacher and possibly the name of a substitute teacher.

Semesters	Discovery materials	Teachers
S1	Subject 1: Subject 2:	
S2	Subject 1: Subject 2:	

Observations:..... ....
....
....

Names and first names of teachers		Subjects taught	Semester	Margins
1				
2				
3				
4				
5				
6				
7				
8				
9				

The sector manager The head of the department

***Reminders**: The nature of the discovery subjects must complement the training and must be chosen according to the needs of the local or regional socio-economic fabric and the availability of specialist teachers in the subject.*

Copies to VRP/VDP

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

University.....
Faculty..... ..
Department.....

Sector :.....
Speciality :.....
Academic year 20.... /20....

THE...../...../20....

MINUTES CONCERNING THE CHOICE OF DISCOVERY MATERIALS FOR THE SECOND YEAR MASTER

The undersigned teachers, after deliberation, have decided on the choice of discovery subjects for the master… proposed in the outline of this master. In this regard, the teachers* whose names follow undertake to ensure the teaching of these subjects. In the event that the training team chooses a subject whose program is not available in the framework, the person in charge of the sector undertakes to send this program to the CPND-ST for enrichment and validation.

* For each subject, it is possible to indicate the name of the main teacher and possibly the name of a substitute teacher.

Semesters	Discovery materials	Teachers
S3	Subject 1: Subject 2:	

Observations:..... ....
....
....

Names and first names of teachers		Subjects taught	Semester	Margins
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

The sector manager The head of the department

***Reminders**: The nature of the discovery subjects must complement the training and must be chosen according to the needs of the local or regional socio-economic fabric and the availability of specialist teachers in the subject.*

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