

Short Syllabus

DIGITAL SYSTEMS

LORRAINE
INP Ensem

ÉCOLE D'INGÉNIEURS CRÉÉE EN 1900

Fall Semester



PROGRAM DESCRIPTION

ENSEM – S9 COURSE CATALOGUE-COURSES AVAILABLE IN ENGLISH

Fall Semester | Master Level / Second Cycle

Engineering Specialisations

This catalogue presents the courses taught in English available to international exchange students at S9 (Master level / second cycle) at ENSEM, Université de Lorraine.

Model Identification and Reduction

Course name	Lectures	Lab work	ECTS	Hours	Course reference
MODEL IDENTIFICATION AND REDUCTION	12	8	2	20	

Course Description

This course introduces data-driven approaches to dynamic-system modelling. Students learn how experimental observations and measurements can be used to identify mathematical models when purely physics-based models are insufficient.

Main Topics

- Data-driven control
- System identification
- Identification of linear systems
- Model reduction
- Model complexity and simplification

Learning Outcomes

Students will be able to:

- apply basic system-identification methods;
- identify dynamic systems from data;
- apply basic model-reduction techniques.

Prerequisites

ENSEM 1A and 2A fundamentals, including inverse problems and system identification.

Assessment

Assessment based on practical test cases.

Engineering Study – Data-Driven Modeling and Control

Course name	Lectures	Lab work	ECTS	Hours	Course reference
ENGINEERING STUDY – DATA-DRIVEN MODELING AND CONTROL	0	20	2	20	

Course Description

This project-based course applies system-identification and model-reduction techniques to realistic engineering applications.

Main Topics

- Model identification
- Model reduction
- Selection of excitation signals
- Model structure selection
- Parameter estimation
- Model validation
- Data-driven control
- MATLAB Identification Toolbox

Learning Outcomes

Students will be able to:

- apply model-identification methods to real engineering problems;
- select appropriate excitation signals and model structures;
- choose suitable estimation algorithms;
- validate identified models;
- develop data-driven control approaches.

Prerequisites

ENSEM 1A and 2A fundamentals, including mathematics and automatic control.

Assessment

Assessment based on engineering test cases.

Event-Based Control

Course name

Lectures

Lab work

ECTS

Hours

Course reference

EVENT-BASED CONTROL

8

8

2

20

Course Description

The course introduces control strategies based on event-triggered or event-based approaches.
(+ 4 hours tutorials)

Learning Outcomes

Students will develop knowledge and practical skills related to event-based control systems.

Assessment

Course assessment according to the teaching format.

Control for Transport and Energy-Conversion Challenges

Course name	Lectures	Lab work	ECTS	Hours	Course reference
CONTROL FOR TRANSPORT AND ENERGY-CONVERSION CHALLENGES			2.5	30	

Course Description

This course develops advanced control skills through a series of engineering case studies related to transport, energy conversion and renewable energy.

Applications

- Three engineering problems are studied: optimisation of energy use in a power converter;
- GPS position estimation;
- control of a wind turbine under disturbed wind conditions.

Learning Outcomes

Students will be able to:

- analyse an engineering problem;
- formulate an appropriate mathematical model;
- apply control and estimation methods;
- address concrete challenges in transport and energy conversion.

Assessment

Engineering-study work and associated deliverables and presentations.

Autonomous and Responsible Vehicle Design Project

Course name

AUTONOMOUS AND RESPONSIBLE VEHICLE DESIGN PROJECT

Lectures

Lab work

ECTS

Hours

Course reference

16

20

4

60

Course Description

Students work as an engineering design team to develop a complete intelligent transportation system. The project involves the development of a mobile robot operating in a small-scale smart-city environment. (+ 24 hours tutorials)

Project Objectives

Students will:

1. design and implement autonomous navigation between predefined points;
2. integrate urban constraints such as traffic lights, road signs, road markings and safety requirements;
3. manage interactions and coordination between several autonomous robots;
4. apply a systems approach combining Data, Systems and Artificial Intelligence.

Learning Outcomes

Students will develop skills in:

- Systems and Robotics: autonomous navigation, localisation, trajectory planning and fault management;
- Data and Computer Vision: environmental perception, road-sign recognition and obstacle detection;
- Artificial Intelligence: adaptive behaviour and dynamic obstacle management;
- Networks and Distributed Systems: vehicle-to-vehicle and vehicle-to-infrastructure communication;
- Embedded Technologies: ROS, Linux, LiDAR, cameras and IMUs;
- Project Management: Agile methods, planning and deliverables;
- Teamwork: collaborative work in multidisciplinary engineering teams;
- Professional Communication: technical presentations and client–supplier interaction.

Teaching Format

The module is organised as a design-office project carried out by teams of four students.
16 hours lectures + 24 hours tutorials + 20 hours practical work

Assessment

- Intermediate project deliverables
- Regular project reviews
- Final project
- Technical report
- Oral presentation and demonstration

Prerequisites

Students should have completed the Autonomous and Connected Systems pathway.

Introduction to Robotics

Course name	Lectures	Lab work	ECTS	Hours	Course reference
INTRODUCTION TO ROBOTICS	14	6	2	20	

Course Description

This course introduces the fundamental concepts required to model, analyse and control robotic systems, with particular emphasis on robotic manipulators and mobile robots.

Main Topics

- Robot kinematics
- Robot configurations
- Forward and inverse kinematics
- Differential kinematics
- Jacobian matrices
- Robot dynamics
- Forces, torques and motion
- Robot control
- Trajectory planning
- Mobile robots
- Locomotion and kinematic modelling

Learning Outcomes

Students will be able to:

- model industrial and mobile robots;
- describe robot configurations and transformations;
- derive basic kinematic and dynamic models;
- analyse robotic-system behaviour;
- design basic robot-control strategies.

Prerequisites

- Mathematics
- Mechanical Modelling
- Automatic Control
- Optimisation

Assessment

Written examination.

Connected Mobility – Distributed Systems and Web Services

Course name

Lectures

Lab work

ECTS

Hours

Course reference

PART 1 - DISTRIBUTED SYSTEMS AND WEB SERVICES

			10	
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Course Description

This component introduces the fundamental concepts involved in distributed applications composed of several autonomous and interacting components.

Main Topics

- Concurrency and parallelism
- Mutual exclusion
- Synchronisation
- Distributed applications
- Web services
- REST APIs
- Python programming
- Multithreading
- Flask

Prerequisites

- Object-oriented programming
- Computer systems and networks

Assessment

- Practical assessment: 1/3
- Written assessment: 2/3

Connected Mobility – Distributed Systems and Web Services

Course name

Lectures

Lab work

ECTS

Hours

Course reference

PART 2 – VEHICLE COMMUNICATION

6

4

10

Course Description

The automotive industry is undergoing a major transformation towards increasingly connected and autonomous vehicles. This component introduces the communication architectures embedded in modern vehicles.

Particular emphasis is placed on the CAN bus, together with emerging technologies such as CAN FD, automotive Ethernet and V2X communication.

Main Topics

- Automotive electronic architecture
- Embedded communication networks
- CAN bus
- CAN frame analysis
- Bus load and response time
- CAN FD
- Automotive Ethernet and TSN
- V2X communication
- Connected-vehicle architectures
- ETSI standards
- Cybersecurity and PKI

Learning Outcomes

- Students will be able to:
- understand the architecture of embedded automotive networks;
- analyse CAN frames and calculate bus load;
- evaluate real-time CAN performance;
- design and assess CAN networks;
- compare CAN, CAN FD and automotive Ethernet;
- explain the principles and applications of V2X;
- identify key cybersecurity vulnerabilities in embedded networks.

Prerequisites

Knowledge of computer networks and Internet of Things (IoT) systems.

Assessment

Written examination.

Connected Mobility – Distributed Systems and Web Services

Course name	Lectures	Lab work	ECTS	Hours	Course reference
PART 3 – VEHICLE DATA ACQUISITION, TRANSMISSION AND PROCESSING	6	4		20	

Course Description

This project-based component applies knowledge of distributed systems, networks and databases to the acquisition, transmission and processing of data from an electric vehicle.

The case study is based on the ENSEM Twizy electric vehicle.

The project reflects typical Internet of Things (IoT) applications encountered in industrial environments.

Main Topics

- CAN-bus data acquisition
- CAN-frame analysis and decoding
- Vehicle data
- Database storage
- Real-time data transmission
- MQTT
- Web servers
- Vehicle monitoring
- Trajectory tracking
- Energy-consumption monitoring
- Industrial diagnostic tools

Learning Outcomes

- Students will develop skills in:
- distributed systems and web services;
- communication networks;
- IoT and embedded systems;
- automotive data acquisition;
- industrial tools such as CANalyzer and OBD-II;
- collaborative engineering and project management.

Prerequisites

- Distributed systems
- Web services
- Computer networks
- IoT systems
- Databases
- Object-oriented programming

Teaching Format

20 hours tutorials / project work

Students work in teams of four.

Assessment

Project report and oral presentation.

Academic / Industrial R&D Project

Course name	Lectures	Lab work	ECTS	Hours	Course reference
ACADEMIC / INDUSTRIAL R&D PROJECT			10	120	

Course Description

This project enables students to apply the knowledge and skills acquired during their engineering studies to a concrete research or industrial development problem.

Projects may be carried out individually or in groups and may be proposed by an academic or industrial partner.

Main Project Stages

- Definition of project objectives
- Requirements and expected outcomes
- Functional and technical specifications
- Design and simulation
- Development
- Validation
- Analysis and reporting

Learning Outcomes

Students will gain experience in carrying out a substantial engineering project and in applying their technical knowledge to an open-ended problem.

Assessment

- Project report
- Oral defence

International Communication

Course name	Lectures	Lab work	ECTS	Hours	Course reference
PROFESSIONAL AND SCIENTIFIC COMMUNICATION	24	0	2.5	24	

Course Description

The English component is organised around two complementary areas: Professional Communication and Scientific Communication.

Professional Communication prepares students to work effectively in international professional environments, including job applications, interviews, personal branding, meetings, negotiations and project presentations.

Scientific Communication focuses on written and oral communication in scientific and technical contexts.

Main Topics

- Job applications and interviews
- CV and personal branding
- Professional communication
- International teamwork
- Meetings and negotiations
- Technical presentations
- Scientific report writing
- Abstract writing
- Technical English
- Explaining and simplifying technical concepts
- Oral scientific communication

Learning Outcomes

Students will be able to:

- communicate effectively in English in professional and scientific contexts;
- produce clear written technical and scientific documents;
- present technical information orally;
- interact effectively in international and intercultural environments.

Prerequisites

B2 level of English.

Assessment

Continuous assessment through written work, oral participation and final assessments.

International Communication

Course name	Lectures	Lab work	ECTS	Hours	Course reference
FRENCH LANGUAGE	24	0	2.5	24	

This course will introduce students to French culture and life in France through linguistic activities and exercises.

Classes will be based on various authentic documents. Through class-work students will improve their ability to build sentences in French while discovering French culture

Learning Outcomes

By the end of the course students will be able to introduce themselves, talk about interests and their environment and ask questions to others about familiar topics.

Students will be given assignments to help them review the points covered in class and prepare for upcoming classes.

Main Topics

- Socio-cultural contents (greetings, family life in France, daily routines, shopping in France, French food, work culture, etc.)
- Communication tasks (greeting people, introducing yourself, speaking about your family and habits, asking something politely, ordering food and drinks, speaking about your experience and your future plans, etc..)
- Grammar (être and avoir, articles, 1st group verbs, present, conditional in polite expressions, future, passé composé etc..)
- Vocabulary (nationalities, adjectives describing personality, family members, the house, frequency adverbs, most useful verbs, shops, food, work, jobs, studies, etc...)

Assessment

regular oral and written tests

LORRAINE INP Ensem

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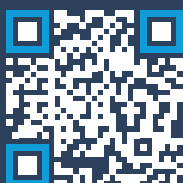
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