ESIGELEC
SCHOOL OF ENGINEERING
SMART AND CONNECTED SYSTEMS

2023-2024

MSC–MASTER OF SCIENCE "MECHATRONICS AND ELECTRICAL ENGINEERING"

PROGRAMME CURRICULUM AND GUIDELINES

PROGRAMME IN PARTNERSHIP WITH INSTITUT NATIONAL POLYTECHNIQUE FÉLIX HOUPHOUËT-BOIGNY (INP-HB) DE YAMOUSSOUKRO – CÔTE D'IVOIRE

Institut National Polytechnique
Félix HOUPHOUËT-BOIGNY

Contents

A – COURSE STRUCTURE & DURATION

The MSc – Master of Science MEE is a 2-year programme. The first year called M1-year is divided into 2 academic periods and 1 period of internship. The second year called M2-year is also divided into 2 academic periods and 1 period of internship.

All the academic periods are carried out on campus at INSTITUT NATIONAL POLYTECHNIQUE Félix HOUPHOUËT-BOIGNY - YAMOUSSOUKRO – CÔTE D'IVOIRE. The academic periods are composed of lectures, tutorials, practical work, projects, and seminars as well as tests and exams. During these periods, faculty members come from ESIGELEC and INPHB, and students have to follow and respect the guidelines and rules defined by INPHB (and approved by ESIGELEC).

The 2 internships can take place in a laboratory or in a company for a period of 4 months minimum and 6 months maximum. The students are helped by ESIGELEC and INPHB to find the internship but **ESIGELEC and INPHB do not "give" internships to the students**. The students have 2 years maximum after the last academic period of M2-year to find, to complete the last internship and to provide ESIGELEC and INPHB with a professional thesis and a presentation in front of a Jury. Failure to do so could result in the refusal of the delivery of the MSc – Master of Science of ESIGELEC to the concerned students.

After they finish the last academic period in INPHB in year N, students maintain their student status of ESIGELEC and INPHB during the following academic year N/N+1 (or until their presentation at the Jury of ESIGELEC in case it happens before the end of the following academic year N/N+1). If at the end of the following academic year N/N+1, students have started but not finished their internship, their student status will be automatically renewed for one more and last academic year: N+1/N+2. But if students have not started their internship, they will have to renew by themselves their student status for the next academic year N+1/N+2, by paying the corresponding fees, or else they will be refused the MSc – Master of Science of ESIGELEC.

B – OBJECTIVES OF THE PROGRAMME

The MSc MEE aims to train professionals and experts in the fields of Mechatronics and Electrical Engineering capable of performing the following functions:

- Engineer in Mechatronics (mastery of complex systems combining mechanics, electronics, automation, electricity)
- Electrical Engineer (studies, design, manufacture of electrical equipment)
- Engineer in Control and operation of complex electrical networks (factory or power station)
- Engineer in Maintenance of complex electrical networks (factory or power plant)
- Security Systems Engineer for complex electrical networks (factory or power plant)

They will study in an international environment with teachers from different countries, which will offer them the possibility to discover new cultures, new methodologies of teaching, and a new language: the English language. They will also have a work experience through the internship they will have to do at the end of the programme.

C – ATTENDANCE POLICY

All lessons, tutorials, seminars, practical work, projects, and conferences are mandatory. Attendance will be checked by the teachers at the beginning of each academic activity. The attendance forms will be collected by the Studies Office of INPHB.

Any student who is not in the classroom 10 minutes after roll call will be considered as absent and will be refused entry into the classroom. The absence will be considered as an unjustified absence.

Any student who arrives in the classroom less than 10 minutes after roll call will be accepted in the classroom, but their tardiness will be indicated on the attendance sheet. Three (3) late arrivals will be considered as an unjustified absence.

In the event of too many unjustified absences (more than 10) in multiple academic activities (including tutorials, practical work, seminars, etc...), ESIGELEC and INPHB can decide the dismissal of the student from the MSc – Master of Science programme.

The justifications of absences (sickness or other specific & accepted situations) will have to:

- ⇨ Be given, or sent, to the Studies Office of INPHB (who has to inform ESIGELEC) within 3 working days, in case of sickness;
- ⇨ Be indicated through an official letter and accepted/signed at least 2 days before, by the Academic Coordinator of the programme at INPHB (who has to inform ESIGELEC), for specific situations.

In case of absences at an examination:

- ⇨ Only the students whose absences have been justified and accepted by the Academic Coordinator of the programme at INPHB will be allowed to resit the examination,
- ⇨ The other students whose absences have not been justified or accepted by the Academic Coordinator of the programme at INPHB will have the mark 0 at the said examination.

D – EXAMINATIONS, SCORES AND ECTS CREDITS

Tests

Tests and quizzes can take any suitable form in function of the teacher's prerogatives (written exam, oral exam, project, report, oral presentation, etc.) and can be done with or without the use of documents or a calculator according to the teacher's instructions. Each test will be weighted and given a mark from 0 to 20.

Scores and ECTS credits

The MSc – Master of Science programme is divided into several weighted modules. Each module represents a certain number of ECTS credits.

The score of a module is the average of the weighted scores of the different evaluations in the module.

The final general score of the student is the result of the weighted averages of all modules included in the MSc – Master of Science programme.

The number of ECTS credits for the MSc – Master of Science programme is equal to the total of all the ECTS credits corresponding to the modules.

One ECTS credit corresponds to about 25 hours of student work (lessons, projects, practical work, exams, personal work).

E – FRAUD AND CHEATING

Any fraud seen by a teacher or a supervisor during an exam, oral presentation, project or practical work will be given a score of 0/20 at the exam, oral presentation, project or practical work.

Examples of plagiarism, fraud, or cheating, include (but are not limited to):

- ⇨ Duplication of another student's work during a written assignment,
- ⇨ Use of document or calculator during an exam in which those elements are forbidden,
- ⇨ Plagiarism (>20%) of reports, presentation, or computing programs, obtained by any means (Book, magazine, other students, electronic files, internet, work previously submitted in another course).

F – GRANTING OF THE MSc – MASTER OF SCIENCE OF ESIGELEC

For each academic period teaching at INPHB, the sum of the ECTS credits related to the modules is 20. For each internship, the number of credits is 20.

ECTS credits associated to a module are obtained by the student from the score 10/20 in the said module. The MSc – Master of Science is granted to the student if at the end of the term of the semesters, the student has 120 ECTS credits in total.

The Jury of ESIGELEC panel for the MSc – Master of Science includes a President, who is member of ESIGELEC, a representative of the Education Authority in the city of Rouen (France), representatives of the managing staff of the school and teachers. The Jury of ESIGELEC will be held up in November, February, April and/or June every year.

If students don't have enough ECTS credits to be granted the MSc – Master of Science, even after the resitting exams that are planned during the 2 following academic years after the end of the last academic period in Ivory Coast, they will receive a certificate from ESIGELEC upon which will be noted the total number of ECTS credits they received in the different modules.

The MSc – Master of Science "Mechatronics and Electrical Engineering", delivered by ESIGELEC to the graduated students is accredited by the Conference of Top Schools of Engineering & Management in France (CGE).

G – RESITTING EXAMS

If a student has less than 10/20 in one or several modules, the student will be asked to resit one or several exams in one or several modules, as proposed by the Academic Coordinator of the programme at INPHB, during the 2 following academic years after the last academic period in Ivory Coast.

If a student does not receive the 20 ECTS credits of the internship, the Academic Coordinator of the programme at INPHB (in agreement with the Academic Coordinator of the MSc programme at ESIGELEC) could:

- ⇨ Request that the student completes a new internship, including a new report and a new oral presentation, or,
- ⇨ Request that the student redoes a new report and/or a new oral presentation, or,
- ⇨ Deny the student another chance to obtain the 20 required ECTS credits, if a fault was committed by the student during the internship.

The new scores obtained at the resit exams in different modules replace the previous averages obtained by the student in the concerned modules.

If the student is absent at a resit exam, the student will be given 0/20 for the resit exam. The new averages of the concerned modules have to be greater than 10/20 to grant the associated ECTS credits to the student.

H – COURSES AND ECTS CREDITS

For the M1-year

PERIODS	TEACHING UNITS	COURSES REFERENCES	COURSES	ACADEMIC MODEL	NUMBER OF HOURS	HOURS/COURSE	ECTS	EVALUATION
M1-A	MODELING AND ADVANCED CONTROLS OF MECHANICAL SYSTEMS	MEE-101	Advanced Automation for Mechatronics	LECTURE	10	18	3	1 EXAM (50%) / 1 PRACTICAL (50%)
				PRACTICAL	8			
		MEE-102	Dynamics and energy of solid systems	LECTURE	4	18	3	1 EXAM (50%) / 1 PRACTICAL (50%)
				TUTORIALS	6			
				PRACTICAL	8			
		MEE-103	Identification of mechatronic systems	LECTURE	4	18	3	1 EXAM (50%) / 1 PRACTICAL (50%)
				TUTORIALS	6			
				PRACTICAL	8			
	MECHATRONIC APPROACH	MEE-104	Mechatronic approach to systems	LECTURE	16	46	5	1 EXAM (50%) / 1 PRACTICAL (50%)
				PRACTICAL	30			
	M1-A PROJECT	MEE-105	Mechatronics Project	PROJECT	30	30	3	DEFENCE
	FINANCIAL MANAGEMENT	MEE-106	Financial management	LECTURE	20	20	3	1 EXAM
TOTAL M1-A					150	150	20	
M1-B	DIGITAL CONTROL AND DESIGN OF INTELLIGENT MECHATRONIC SYSTEMS	MEE-107	Numerical control for mechatronics	LECTURE	12	20	3	1 EXAM (50%) / 1 PRACTICAL (50%)
				PRACTICAL	8			
		MEE-108	Design of intelligent mechatronic systems	LECTURE	8	20	3	1 EXAM (50%) / 1 PRACTICAL (50%)
				PRACTICAL	12			
	RENEWABLE ENERGIES	MEE-109	Wind power	LECTURE	14	30	4	1 EXAM (50%) / 1 PRACTICAL (50%)
				TUTORIALS	4			
				PRACTICAL	12			
		MEE-110	Solar energy	LECTURE	18	30	4	1 EXAM
				PRACTICAL	12			
	M1-B PROJECT	MEE-111	Solar Energy Project	PROJECT	30	30	3	DEFENCE
	MARKETING	MEE-112	Marketing	LECTURE	20	20	3	1 EXAM
TOTAL M1-B					150	150	20	
M1 INTERNSHIP	INTERNSHIP	MEE-1000	Internship	Internship	4 to 6 months	4 to 6 months	10	Assessment form
				Thesis/Dissertation			10	Thesis + Defence
TOTAL M1					300	300	60	

For the M2-year

PERIODS	TEACHING UNITS	COURSES REFERENCES	COURSES	ACADEMIC MODEL	NUMBER OF HOURS	HOURS/COURSE	ECTS	EVALUATION
M2-A	ELECTROMECHANICAL CONVERSION CHAIN	MEE-201	Converters	LECTURE TUTORIALS PRACTICAL	14 4 12	30	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-202	Control of converters	LECTURE TUTORIALS PRACTICAL	8 4 8	20	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-203	Electrical machines and controls	LECTURE TUTORIALS PRACTICAL	10 8 12	30	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-204	Vehicles and Communication Networks	LECTURE PRACTICAL	6 4	10	1	1 EXAM
	ENERGY AND APPLICATIONS	MEE-205	Energies	LECTURE TUTORIALS PRACTICAL	12 6 12	30	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-206	Energy management	LECTURE TUTORIALS PRACTICAL	12 6 12	30	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-207	Electrical networks	LECTURE PRACTICAL	10 10	20	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-208	Smart Grid	LECTURE	10	10	1	1 EXAM
	M2-A PROJECT	MEE-209	Power electronics project	PROJECT	30	30	3	DEFENCE
	MANAGEMENT	MEE-210	Management	LECTURE	20	20	3	1 EXAM
TOTAL M2-A					230	230	20	
M2-B	MODELING AND CONTROLS OF INTELLIGENT MECHATRONIC STRUCTURES	MEE-211	Advanced mechanics	LECTURE TUTORIALS	8 6	14	1	1 EXAM
		MEE-212	Active control and monitoring of intelligent structures and systems	LECTURE TUTORIALS	14 6	20	2	1 EXAM
	MULTI-PHYSICAL APPROACH FOR MODELING MECHATRONIC SYSTEMS	MEE-213	Bond approach of graphs for the modeling of mechatronic systems	LECTURE PRACTICAL	12 8	20	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-214	Multi-physics design of mechatronic systems	LECTURE PRACTICAL	4 12	16	1	1 EXAM (50%) / 1 PRACTICAL (50%)
	ENERGY CONVERSION AND TRANSMISSION FOR DIFFERENT INDUSTRIAL APPLICATIONS	MEE-215	Advanced power electronics	LECTURE TUTORIALS PRACTICAL	8 4 8	20	2	1 EXAM (50%) / 1 PRACTICAL (50%)
		MEE-216	Electric power transmission and distribution networks	LECTURE PRACTICAL	22 8	30	2	1 EXAM
	ENERGY CONTROL AND DISTRIBUTION SYSTEMS, STANDARDS AND INDUSTRIAL RISKS	MEE-217	Distribution control and command system	LECTURE PRACTICAL	10 10	20	2	1 EXAM
		MEE-218	Digital control by DSP	PRACTICAL	10	10	1	1 PRACTICAL
		MEE-219	Industrial risks	LECTURE	10	10	1	1 EXAM
	DESIGN OFFICE	MEE-220	Request for proposal	LECTURE	30	30	3	DEFENCE
	ENTREPRENEURSHIP SEMINAR	MEE-221	Business approaches	SEMINAR	30	30	3	DEFENCE
TOTAL M2-B					220	220	20	
M2 INTERNSHIP	INTERNSHIP	MEE-2000	Internship	Internship	4 to 6 months	4 to 6 months	10	Assessment form
				Thesis/Dissertation			10	Thesis + Defence
TOTAL M2					450	450	60	

I – COURSES DESCRIPTION

Note 1: The programme can be modified in keeping with the faculty member's prerogatives or organizational constraints.

Note 2: All courses are delivered face-to-face, on campus, with all required safety measures. However, modules may be delivered partially or totally online and/or through distance mode, in keeping with possible changes in the health crisis or any other circumstances beyond our control and as advised by the relevant French and/or Ivorian Government authorities.

MEE-101 : Advanced automation for mechatronics

Module title	**Advanced automation for mechatronics**
Number of hours	18h (LECTURE 10h, PRACTICAL 8h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	● Identify the technical needs of mechatronic systems. ● Translate technical specifications into specifications. ● Design advanced control/command techniques. ● Make a comparative study of control methods by status feedback.
Programme	● State representation of sampled and discrete systems ● Governability and Observability of discrete systems ● Synthesis of discrete systems in state representation ● Control of mechatronic systems in real time
Teachers and Status	Dr Kouadio Eugène ALI, Academic Dr Edoé Fernand MENSAH, Academic

MEE-102 : Dynamics and energy of solid systems

Module title	**Dynamics and energy of solid systems**
Number of hours	18h (LECTURE 4h, TUTORIALS 6h, PRACTICAL 8h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Determine the connection unknowns or the specified external forces in the case where the movement is imposed. Give the law of motion in the form of differential equations when the external forces are known. To exploit and (or) complete a digital model to evaluate forces or law of motion. Essential objectives: Identify the material symmetries of a solid and discuss the simplification of kinetic quantities (center of inertia, matrix of inertia). Calculate kinetic quantities (center of inertia, matrix of inertia, moments of inertia) in the case of simple geometries. Create a geometric model with a volume modeler in order to obtain kinetic quantities in the case of complex parts. Complete a numerical mechanical model (definition of mechanical actions, free and imposed movements, etc.) in order to solve a dynamic problem. Calculate kinetic quantities (kinetic torsor, dynamic torsor, kinetic energy) in the case of simple movements (rotation around a fixed point, translation, plane movement). Express the Galilean power developed by a mechanical action. Express the power of inter-force between 2 solids. Apply the principles and theorems of dynamics to solve a given problem. Highly recommended objectives: Choose the theorem(s) adapted to the resolution of a problem. If necessary, use the notions of work and energy in the energy approach to a dynamic problem. Elaborate the block diagram or the transfer function of an energy chain from the dynamic equations.
Programme	• Dynamics of solid systems Introduction Kinetics. Definition and relations for a material system E with conservative mass Kinetics. Special case of the solid The fundamental principle of dynamics • Kinetic energy theorem Introduction Notion of power Kinetic energy theorem Complements: work and potential energy Methodology
Teachers and Status	Ben Matthieu KOUASSI, Professional Jacques SORO, Professional

MEE-103 : Identification of mechatronic systems

Module title	**Identification of mechatronic systems**
Number of hours	18h (LECTURE 4h, TUTORIALS 6h, PRACTICAL 8h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	The aim of this course is to present original methods for mechatronic systems (eg robot manipulators, spring mass systems, etc.). We will decline two methods. The first is based on parametric estimation techniques (simple least squares and recursive least squares methods). The second will be based on adaptive observers who jointly estimate system states and unknown parameters.
Programme	● Introduction of the problem of identification, and of the model of a mechatronic system ● Introduction of adaptive observers ● Adaptive observer synthesis for a discrete linear model ● Application of identification methods to several mechanical systems ● Application of adaptive observers to several mechanical systems ● Identification of the parameters of a mass-spring system of order 4 ●Synthesis of adaptive observer of a mass-spring system of order 4
Teachers and Status	Dr Kouadio Eugène ALI, Academic Jacques SORO, Professional

MEE-104 : Mechatronic approach to systems

Module title	**Mechatronic approach to systems**
Number of hours	46h (LECTURE 16h, PRACTICAL 30h)
ECTS credits	5
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	This module aims to provide MSc MEE students with an approach, knowledge and skills for the synergistic integration of electronics, mechanics, automation and real-time computing for the design and production. systems based on electric actuators (servomotor, stepper motor, DC motor). In particular, aspects of multi-physical modeling, interface electronics and digital control and monitoring are addressed. This module alternates course and workshop sessions and is structured around two projects: the motorized pan/tilt turret and the motor bench.
Programme	This module begins with a brief introduction during which the learning objectives, the pedagogical system put in place and the evaluation methods are presented in detail. Tutored sessions are then planned during which the students develop two technical studies on the pan/tilt turret and engine bench projects. In parallel, introductory sessions to the Amesim modeling tool are also planned. Finally, workshop sessions are scheduled to model, simulate and analyze the system on the one hand and to integrate the control laws into a microcontroller board on the other.
Teachers and Status	Dr Somo COULIBALY, Academic Dr Jean-Paterne KOUADIO, Internal and Academic

MEE-105 : Mechatronics project

Module title	**Mechatronics project**
Number of hours	30h (PROJECT 30h)
ECTS credits	3
Evaluation	1 DEFENCE
Goals	**Essential objectives** ● Define, identify and describe the operation of a mechatronic system. ● Use several themes: mechanics, electronics, automation and real-time computing. ● Analyze and distinguish the different functionalities of a mechatronic system. ● Design a mechatronic platform meeting a particular need (expressed in the specifications). ● Organize work in a group and plan activities. ● Choose, justify and judge the solutions adopted/adapted following a given problem. ● Create a system integrating electronics, mechanics, automation and real time in order to perform well-defined tasks. ● Implement a scheme based on one or more sensors. **Highly recommended Objectives** ● Be able to extract relevant information from technical documentation in English. ● Cite examples of mechatronic applications. ● Use libraries of functions provided to create an application according to given specifications. ● Presenting to an audience in a synthetic way the result of technical work (knowing how to present, knowing how to communicate).
Programme	● Definition of the proofreader's specifications ● Modular presentation of the different parts o Mechanical part o Electronic/Automatic part ●Interconnections of modules and simulation
Teachers and Status	Dr Edoé Fernand MENSAH, Academic

MEE-106 : Financial management

Module title	**Financial management**
Number of hours	20h (LECTURE 30h)
ECTS credits	3
Evaluation	1 EXAM
Goals	Acquire the basics of general accounting and financial analysis. Understand how a company's financial statements, balance sheet and income statement are prepared. Being able to read them, interpret them and have a critical look. Be able to make a financial diagnosis to identify if the company is viable and profitable, Being able to understand how the company is financed. Being able to carry out a static analysis (functional and financial) and a dynamic analysis (from one or more balance sheets).
Programme	● The need for financial information for all stakeholders with distinct needs ● The operation of the accounts and the chart of accounts ● Accounting organization ● Techniques for recording accounting operations. ● Preparation of the balance sheet and income statement ● Stages of diagnosis ● Analysis of activity and profitability: intermediate management balances (SIG), self-financing capacity (CAF by the two calculation methods), economic profitability and financial profitability (the leverage effect/the effect club). ● Analysis of the financial equilibrium: the functional balance sheet (construction, calculation of the FR, BFR, BFRE and BFRHE), the cash flows (cash flow table, ex of the OEC table) and the main financial structure ratios as well as their significance.
Teachers and Status	Mr SEHI BI Ernest, Professional

MEE-107 : Numerical control for mechatronics

Module title	**Numerical control for mechatronics**
Number of hours	20h (LECTURE 12h PRACTICAL 8h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	The development of computers has caused significant changes in the design of control/command systems. Their computing power and their low cost make them able to fully take charge of the control aspects with performances clearly superior to those of analog regulators. At the end of this module, students are able to: ● Modeling mechatronic systems in digital, ● Know how to choose the sampling period, ● Determine the stability of mechatronic systems, ● Designing digital correctors, ● Performed a comparative study of digital control methods according to technical specifications.
Programme	● Representation of sampled systems ● Stability of sampled systems ● Control by polynomial methods - Dominant poles method - Heads or Tails answer - Zdan method - RST corrector ● Minimal time digital control ● Case study: digital control of an air intake valve for a gasoline engine
Teachers and Status	Dr ALI Kouadio Eugène, Academic Dr KASSI Koutoua Simon, Academic

MEE-108 : Design of intelligent mechatronic systems

Module title	**Design of intelligent mechatronic systems**
Number of hours	20h (LECTURE 8h PRACTICAL 12h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	The objective of this course is to provide future MSc MEE engineers with solid scientific and technological knowledge to study, design, simulate and optimize innovative mechatronic systems through a multidisciplinary approach. TARGETED LEARNING OUTCOMES - Know how to design and size the components (controllers, actuators, sensors) of an intelligent mechatronic system that can be autonomous in its decision-making - Being able to model the mechanical structure of an intelligent mechatronic system using CAD software. - Be able to design all the on-board electronics of the intelligent mechatronic system - Be able to experimentally implement an intelligent mechatronic system
Programme	During this course, MSc MEE students will cover the following points • Multiphysics modeling and optimal design of systems, • Miniaturization of a structure of a mechatronic system, • Embedded energy management for an intelligent mechatronic system. • A review of compact and innovative actuators and sensors fitted to a mechatronic system. • Simulation of the mechatronic system using CAD software. • Experimental implementation of the system
Teachers and Status	Dr COULIBALY Somo, Academic M. KOUASSI Alexis, Professional

MEE-109 : Wind power

Module title	**Wind power**
Number of hours	20h (LECTURE 12h PRACTICAL 8h)
ECTS credits	3
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Be able to conduct the sizing and installation of a high-power wind farm, including by completing the impact study file This module aims to provide skills in both the technical aspects of wind turbines (operation, principle, technology, performance) and the installation of wind turbines either for the purpose of micro-production of electricity or in wind farms.
Programme	1) Notion of aerodynamics and boundary layer applied to wind power 2) Architecture of wind turbines (blade control, hydraulic circuit, brake, electrical energy conversion chain, usual generators, etc.) 3) Sizing 4) Regulations for installation of aerogenerators (low and high power) - Installation and operation of aerogenerators (wind farms) - Legislation (urban planning laws), regulations - Research of a site and determination of its wind potential 5) Coupling to the electricity network and operation of wind turbines 6) Profitability of a wind farm 7) Complete study of the location of a wind farm (calculation of producible, sizing, environmental impact, photomontages, etc.)
Teachers and Status	Dr KOFFI Ekoun Paul-Magloire, Academic M. HIEN Sié Georges, Professional

MEE-110 : Solar energy

Module title	**Solar energy**
Number of hours	30h (LECTURE 18h PRACTICAL 12h)
ECTS credits	4
Evaluation	1 EXAM
Goals	Know how to use solar energy as a source of heat and electricity
Programme	● Principle, sizing ● Ownership of cells, technologies ● Inverters, modules and chains ● Recycling, protections, surge arresters ● Production estimates ● Economic aspect, investment ● Administrative aspect, contacts, etc.
Teachers and Status	Dr AZZOUZ Yacine, Internal and Academic

MEE-111 : Solar Energy Project

Module title	**Solar Energy Project**
Number of hours	30h (PROJECT 30h)
ECTS credits	3
Evaluation	1 DEFENCE
Goals	Respond to the specifications of the call for tenders for a photovoltaic installation.
Programme	● Estimation with the PVSOL software of the electrical production of a photovoltaic installation. Reading of sun masks (Solemetric Suneye device) ● Choice and definition of the components of a PV installation (PVSOL software) ● Calculation of electrical protections and definition of the connection to the electrical network (SolarCalc software).
Teachers and Status	Dr KOFFI Hubert Azoda, Academic

MEE-112 : Marketing

Module title	**Marketing**
Number of hours	20h (LECTURE 20h)
ECTS credits	3
Evaluation	1 EXAM
Goals	● Address the main constituent concepts of a marketing culture. ● Define the essential stages of a marketing approach and attitude. ● Develop personal knowledge of current marketing developments.
Programme	● Market studies ● Consumer behavior ● Strategic analysis ● Marketing decisions ● Marketing mix variables ● Direct marketing
Teachers and Status	Mr SEHI BI Ernest, Professional

MEE-201 : Converters

Module title	**Converters**
Number of hours	30h (LECTURE 14h TUTORIALS 4h PRACTICAL 12h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	● Master the different assemblies used for the conversion of DC/DC, DC/AC and AC/DC energy. ● Calculate harmonics and power losses in an inverter ● Know how to mount a variable speed drive
Programme	● Reminders and introduction to AC-DC converters ● DC/DC converters: Buck, Boost, Buck-Boost, Inductive storage chopper, Reversible choppers (multiquadrant) ● DC/AC converters: Single-phase inverter, Three-phase inverter, Multilevel inverter, Harmonics and Fourier transform and Power losses ● Variable speed drive and its applications
Teachers and Status	Dr AZZOUZ Yacine, Academic

MEE-202 : Control of converters

Module title	**Control of converters**
Number of hours	20h (LECTURE 8h TUTORIALS 4h PRACTICAL 8h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	● Learn and master the different types of control for converters. ● Designing the digital controls of the converters.
Programme	● PWM control for single-phase and three-phase inverters ● Digital control for inverters
Teachers and Status	Dr COULIBALY Somo, Academic Dr KASSI Koutoua Simon, Academic

MEE-203 : Electrical machines and controls

Module title	**Electrical machines and controls**
Number of hours	30h (LECTURE 10h TUTORIALS 8h PRACTICAL 12h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	● Study and know alternating current machines and their application as well as their control
Programme	● Reminders and introduction to alternating current machines ● Three-phase asynchronous motor ● Three-phase synchronous machine ● Permanent magnet synchronous motor ● Vector control
Teachers and Status	Dr KASSI Koutoua Simon, Academic Dr KONE Gbah, Academic

MEE-204 : Vehicles and communication networks

Module title	**Vehicles and communication networks**
Number of hours	10h (LECTURE 6h PRACTICAL 4h)
ECTS credits	2
Evaluation	1 EXAM
Goals	Develop and design embedded electronic systems for industrial applications. Analyze an existing architecture.
Programme	● Economic aspects of the automobile market ●Mechanical / electronic interface ● Automotive electronics and functions ● Electronic architecture of embedded systems ● Different types of sensors ● Innovative developments ● Computers, microprocessors, DSPs, FPGAs ● Specifications and its constraints ● Examples of development ● Management methods ● Application examples ● Techniques for detecting and processing errors in an electric vehicle
Teachers and Status	M. KONE Siriky, Professional

MEE-205 : Energies

Module title	**Energies**
Number of hours	30h (LECTURE 12h TUTORIALS 6h PRACTICAL 12h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Know the different types of energy, analyze resources and consumption and size a power plant. Master the different players in the conversion of electrical energy. Analyze the effects of conventional energies. Analyze the effects of renewable energies. Know the method of storing and transmitting energy. Know the principle and operation of HVAC and HVDC Master technical sizing tools (Windpro etc.).
Programme	● Introduction and physical reminders: power, kinetic energy, energy storage. ● Production of electrical energy ● Conversion of electrical energy ● Renewable energy: Wind, Solar, Hydraulic
Teachers and Status	Dr SAKO Mohamed Koïta, Academic

MEE-206 : Energy management

Module title	**Energy management**
Number of hours	30h (LECTURE 12h TUTORIALS 6h PRACTICAL 12h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Mastering all the infrastructures for transporting electrical energy from production centers to electricity consumers. Analyze three-phase electrical networks in normal and disturbed conditions. Know the grouping of three-phase transformers. Master the design tools for an electrical installation: TR-CIEL, CANECO HT and BT, ELEC CALC, AUTOCAD MEP, ECODIAL.
Programme	● Method of symmetric components on unbalanced systems ● Distribution network, constituent elements, sizing ●Choice of protections ● Earth connection diagram or neutral system ● Design and construction of an electrical installation
Teachers and Status	Dr N'CHO Janvier Sylvestre, Academic

MEE-207 : Electrical networks

Module title	**Electrical networks**
Number of hours	20h (LECTURE 10h PRACTICAL 10h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Master the constraints related to the transport of electrical energy.
Programme	Transport and distribution of energy, electrical protection, earthing, design and construction of an electrical installation, etc.
Teachers and Status	Dr KONE Gbah, Academic M. N'KOU N'kou Paterne, Professional

MEE-208 : Smart Grid

Module title	Smart Grid
Number of hours	10h (LECTURE 10h)
ECTS credits	1
Evaluation	1 EXAM
Goals	The objective of this course is to introduce the concept of Smart Grid which is a bi-directional electric and communication network that improves the reliability, security, and efficiency of the electric system for small to large-scale generation, transmission, distribution, and storage. It included software and hardware applications for dynamic, integrated, and interoperable optimization of electric system operations, maintenance, and planning; distributed generation interconnection integration; feedback and controls at the consumer level".
Programme	● Introduction and Definitions ● Conceptual Mode ● Stakeholders & Drivers ● Applications & Technologies o Advanced Metering Infrastructure o Smart Meter o Distribution Grid Management o Advanced Control systems o Renewables Integration o Energy Storage ● Electric Vehicle Integration
Teachers and Status	M. N'KOU N'kou Paterne, Professional

MEE-209 : Power electronics project

Module title	**Power electronics project**
Number of hours	30h (PROJECT 30h)
ECTS credits	3
Evaluation	1 DEFENCE
Goals	Based on specifications, design, study, size and manufacture a switching power supply.
Programme	● Size and build a 3-winding transformer, magnetic section, number of turns, wire section, skin effect. ● Dimension and manufacture power electronics components, MOS and diodes. ● Dimension and produce the filtering elements. ● Generate a transistor command.
Teachers and Status	Dr COULIBALY Somo, Academic Dr KASSI Koutoua Simon, Academic

MEE-210 : Management

Module title	**Management**
Number of hours	20h (LECTURE 20h)
ECTS credits	3
Evaluation	1 EXAM
Goals	Teach and develop reflection on the practice of management Discover the different dimensions of management and activate the right levers Understanding the managerial dimension in the engineering profession
Programme	● Understand the role of manager ● The effective components of management ● Success tools for leading others ● The position of the manager-coach
Teachers and Status	Mr SEHI BI Ernest, Professional

MEE-211 : Advanced mechanics

Module title	**Advanced mechanics**
Number of hours	14h (LECTURE 8h TUTORIALS 6h)
ECTS credits	1
Evaluation	1 EXAM
Goals	At the end of this module, students will be able to use Lagrange mechanics as well as vibration mechanics for the description and analysis of a complex mechanical system..
Programme	• Multibody systems • Analytical mechanics • Vibration mechanics
Teachers and Status	M. KOUASSI Alexis, Professional M. KOUASSI Ben Matthieu, Professional

MEE-212 : Active control and monitoring of intelligent structures and systems

Module title	**Active control and monitoring of intelligent structures and systems**
Number of hours	20h (LECTURE 14h TUTORIALS 6h)
ECTS credits	2
Evaluation	1 EXAM
Goals	At the end of this training, students of the MSc MEE will be able to analyze, monitor the integrity and improve the performance of a mechatronic system subjected to vibrations and more particularly: • Explain vibration phenomena • Distinguish the main actuators and sensors • Implement active control laws • Implement structural integrity control strategies
Programme	● Intelligent Structures and Systems ● System health monitoring ● Health control of structures ● Active control of systems
Teachers and Status	Dr KOBENAN Kouamé Jean-Moïse, Academic

MEE-213 : Bond Graphs approach for modeling mechatronic systems

Module title	**Bond Graphs approach for modeling mechatronic systems**
Number of hours	20h (LECTURE 12h PRACTICAL 8h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	The final goal is to go beyond the analytical approach of the field of study taught upstream to acquire a global "systemic" vision for the analysis and synthesis of complex systems implementing multiple energies, to propose an approach procedure to the “mechatronic design” going from the analysis of customer needs to the different stages of design, production, validation, to associate with this procedure the methodologies and tools, in particular the new validation techniques during design (HIL) and (SIL) and bond graphs, to learn how to develop a systematic approach to the design of engineering systems from the Detailed Instrument Plans (ISO) to the computerization of their implementation.
Programme	**LECTURE** • Introduction to the integrated design of engineering systems o Definitions, needs and context. o Complexity of industrial systems, Why a system approach and a unified language? o Different representations of complex systems; o Which models for mechatronic design; • Tools for integrated design o Prototyping methodology; o Hardware in the Loop (Methodology - How to place HIL stages in the lifecycle; o Interests of the HIL approach - Potential gains. HIL support tools; o Software in the Loop (SIL); o Modeling language: bond graphs. ; o Why bond graphs? o History, Definition; Representation, Paynter diagram and functional models o Power variables in engineering systems; o Construction of models for multi-physical systems (electrical, mechanical, thermodynamic, chemical, etc.); o Algorithmic level of modeling; Causality assignment rule; o Simulation software (Symbols, Matlab). • Real case study **PRACTICAL** Students will integrate their acquired theoretical knowledge into a globally coherent vision of an integrated design project of a real system. The actual process or system to be studied is proposed by the student. Otherwise, the topics to be covered (suggested by the teacher) relate to various fields: transport (vehicle dynamics), energy systems (process engineering), robotics, etc.
Teachers and Status	M. SEGLA Sessien, Professional

MEE-214 : Multi-physics design of mechatronic systems

Module title	**Multi-physics design of mechatronic systems**
Number of hours	16h (LECTURE 4h PRACTICAL 12h)
ECTS credits	1
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Make students aware of the constraints related to electromagnetic compatibility and thermal during the design phases of mechatronic systems. The courses are illustrated by industrial issues and by practical work on multi-physics simulations based on 3D CAD software. These practicals allow you to study the impact of thermal and EMC phenomena on the mechanical design of a system.
Programme	● Introduction to heat transfer modes (conduction, convection, radiation) ● Application for power electronic components ● Stationary problems, transient response ● Thermal interface materials ● Cooling flow balancing ● Thermal problems in the electronics industry, example of RF power amplifiers ● Thermal measurement tools for electronics ● Simulation tools: commercial products and limitations EMC part ● Introduction to EMC o General definition o Concrete case of EMC issues, Specificity of the automotive field o Equivalent models of passive components in HF ● Coupling mechanisms: o Radiation o Coupling Crosstalk Coupling by common impedance Field-to-wire / field-to-loop coupling – elementary Field-to-wire coupling – Agrawal – Taylor – Rachidi ● Practical work: o Crosstalk analysis – Basics of implementing shields. o Implementation of a topological approach Multi-physics simulations • Use of 3D multi-physics simulation software to study the impact of thermal and EMC phenomena on the mechanical design of a system.
Teachers and Status	Dr KOFFI Ekoun Paul-Magloire, Academic

MEE-215 : Advanced power electronics

Module title	**Advanced power electronics**
Number of hours	20h (LECTURE 8h TUTORIALS 4h PRACTICAL 8h)
ECTS credits	2
Evaluation	1 EXAM (50%) / 1 PRACTICAL (50%)
Goals	Master the operating principles of new assemblies used in PE. Know the different assemblies used in switching power supplies and size them. Act on the speed of alternative electric motors, operating in vector or scalar control
Programme	1) New structures in power electronics o Resonance inverter o Multilevel inverters o Soft switching 2) Switching power supplies o Non-isolated Buck power supply o Boost converter o Buck Boost Converter o Inductive storage power supply. o Capacitive storage power supply o Isolation transformer in power electronics o Fly-Back feeding o Fly-Back supply in asymmetrical half bridge o Multi-output fly-back power supply o Forward Power o Forward power supply in asymmetrical half bridge 3) Vector control
Teachers and Status	Dr COULIBALY Somo, Academic Dr KASSI Koutoua Simon, Academic

MEE-216 : Electric power transmission and distribution networks

Module title	**Electric power transmission and distribution networks**
Number of hours	30h (LECTURE 22h PRACTICAL 8h)
ECTS credits	2
Evaluation	1 EXAM
Goals	Present the system of production, transport and distribution of electrical energy. Master the adjustment and organization of electrical systems and protections. Know the security and protection of electrical networks.
Programme	● Interconnection of transport networks ● Power distribution in an electrical network, modeling and equations ● Tension adjustment ● Limitation of reactive power transits ● Frequency setting ● Protections and security
Teachers and Status	Pr. YEO Zié, Academic

MEE-217 : Distribution control and command system

Module title	**Distribution control and command system**
Number of hours	20h (LECTURE 10h PRACTICAL 10h)
ECTS credits	2
Evaluation	1 EXAM
Goals	Continuously monitor electrical power distribution networks Mastering the diversity of information in an energy distribution network Analyze and manage the geographical dispersion of electrical equipment
Programme	● Temporary or permanent operation of internal production groups ● Management of energy consumption according to the cost of energy ● Reactive energy compensation ● Transfer of a faulty source by a backup source ● Network load management ● Inter-tripping of breaking devices ● Switching of homopolar generators ● Power quality control ● Multifunction electrical programming
Teachers and Status	Dr KONE Gbah, Academic

MEE-218 : Digital control by DSP

Module title	**Digital control by DSP**
Number of hours	10h (PRACTICAL 10h)
ECTS credits	1
Evaluation	1 PRACTICAL
Goals	Acquire the methodology to generate digital controls for industrial applications.
Programme	● General information on digital controls ●DSP/FPGA areas of use ● Internal architecture ● Generation of control algorithms ● Digital signals ● Example of command programming
Teachers and Status	M. KONE Siriky, Professional

MEE-219 : Industrial risks

Module title	**Industrial risks**
Number of hours	10h (LECTURE 10h)
ECTS credits	1
Evaluation	1 EXAM
Goals	Industrial risk analysis and hazard study. Means of prevention and protection.
Programme	● Electrical authorization (awareness) ● Protection against direct and indirect contact ● Regulatory measurements and tests ● Pollution problems on electrical networks
Teachers and Status	Dr KOUADIO Léopold, Academic and Professional

MEE-220 : Request For Proposal

Module title	**Request For Proposal**
Number of hours	30h (LECTURE 30h)
ECTS credits	3
Evaluation	1 DEFENCE
Goals	The study relates to a special theme and can cover all levels of the installation, equipment or special electrical machines.
Programme	● Specifications or technical description ● Design and realization of a project ● Feasibility study of a project ● Calculations and numerical simulation ● Implementation follow-up ● Comparison of systems ● Document management for client ● Technical assistance
Teachers and Status	Dr KOUADIO Jean-Paterne, Internal et Academic

MEE-221 : Business approaches: contractor engineer

Module title	**Business approaches: contractor engineer**
Number of hours	30h (SEMINAR 30h)
ECTS credits	3
Evaluation	1 DEFENCE
Goals	Replacing business creation and the development of new activities in a changing economic context Check the attraction for entrepreneurship
Programme	● The business takeover or development project and its structuring ● The different aspects of editing ● Qualities, aptitudes and skills of the contractor engineer ● Case study
Teachers and Status	M. VALLOIS Alain, Internal et Professional

J – INTERNSHIP AND PROFESSIONAL THESIS

There are 2 internships in the MSc programme : a first one at the end of the 1st year (technical internship) and a second one at the end of the 2nd year (professional thesis). Each internship will take place either in a company or in a research laboratory in a university. Students are encouraged to do their internships in Ivory Coast, but they can do them in other countries. The duration of each internship is 4 months minimum and 6 months maximum. INPHB or even ESIGELEC will help the students to find their internships but will not give internships to the students.

The validation of an internship will be based on criteria such as the innovative character of the subject and its adequacy with the regards to the contents of the programme. The internships must be first accepted by the Academic Coordinator of the MSc – Master of Science programme of ESIGELEC, before the student starts an internship, otherwise the internship may not be validated by ESIGELEC. But the work placement agreement may be signed either by INPHB or ESIGELEC, depending on the situation.

A teacher of ESIGELEC will contact the student at least one time during the internship. In the event of questions regarding the internship, the preparation of the oral presentation or the preparation of the report (in first year) or the professional thesis (in second year), the student can contact either the teacher or the Academic Coordinator of the MSc – Master of Science programme at ESIGELEC or at INPHB directly, during the period of each internship.

A professional thesis will have to be completed during the internship in second year. The subject of the thesis will be chosen by the student and validated by the Academic Coordinator of the MSc – Master of Science programme of ESIGELEC one month maximum after the beginning of the internship.

The thesis defence (in second year) or oral defense (in first year) will be presented at INPHB to a Jury composed at minimum of a President (from ESIGELEC / on site or online), two teachers from ESIGELEC (on site or online), plus 2 teachers from INPHB (on site). The industrial tutor could also participate, if it is possible. Thesis defences/oral defenses are planned 2 months maximum after the end of the internship, in preference at the end of October, of January, of March or of May. The professional thesis/report will have to be sent to ESIGELEC and INPHB, two weeks minimum before the date of the thesis defence/oral defense. The duration of an oral examination is **60 minutes** (30 minutes of presentation + 15 minutes of questions + 10 minutes of evaluation + 5 minutes of restitution).

A student has 2 years maximum after the last academic period in INPHB, to find his/her final internship, complete it and provide ESIGELEC and INPHB with a professional thesis and an oral presentation of the professional thesis, otherwise they will be ineligible for graduation at ESIGELEC.

K – STUDY BOARD AND EVOLUTION OF THE MSc – MASTER OF SCIENCE PROGRAMME

The aim of the Study Board is to think about the evolution of the contents of the programme. Its aim is also to make sure that the contents of the course and that the equipment used in the labs corresponds to the needs and to the requirements of the related industries.
There is at least one meeting of the Study Board every two years at ESIGELEC.
The members of the Study Board are representatives of the related industries, the universities (including representatives of INPHB) and ESIGELEC.

A meeting between the Academic Coordinator of the MSc – Master of Science programme at INPHB or at ESIGELEC and the teacher is completed at the end of each course in Ivory Coast, in order to speak about the evolution of the contents, the equipment and the possible problems which may have occurred during the module.

A meeting is also planned every month (or more when it is required) between the Academic Coordinator of the MSc – Master of Science programme at INPHB and/or ESIGELEC and the students in order to speak about possible academic or non-academic problems.

The two Academic Coordinators of the MSc. programme at ESIGELEC and at INPHB use to communicate together all over the year for any matter in relation with the twinning programme and/or the students.

L – SELECTION OF CANDIDATES AND JURY OF ADMISSION

Eligibility

All candidates must have, at least, a Bachelor's degree in engineering corresponding to 3 years of higher education. They need to have a good level of English and a strong motivation.

Selection of candidates

Candidates are selected through:

- ⇨ A pre-selection done by INPHB, and,
- ⇨ An application form, and,
- ⇨ An interview of language and motivation completed online with representatives of ESIGELEC and INPHB.

Deadline to apply

The deadline to apply is the 30th of May to begin the first academic semester in September at INPHB campus.

Admission into the MSc – Master of Science

After reception of the application form and after the interview of language and motivation is completed, ESIGELEC and INPHB will make and communicate their decision regarding the possibility of admission of the student into the programme, in under 2 weeks maximum.

Tuition Down Payment

Students who are accepted receive a Conditional Admission. They must pay directly to INPHB 50% of the fees for the entire MSc programme, before the end of July at the latest and before the beginning of the first academic period, before receiving a Final Admission from ESIGELEC. The remaining part of the fees for the entire MSc programme have to be paid by the students directly to INPHB again, before the end of January.

Students who fail to do so may be refused permission to participate in courses at INPHB.

M – TUITION FEES

The total tuition fees due to ESIGELEC and INPHB are 3506 € per student / year. There are no application fees.

N – SCHOLARSHIPS OF EXCELLENCE FROM ESIGELEC AND INPHB

INPHB and ESIGELEC provide the scholarship at a ratio of 10:1 for each batch and based on the final academic results obtained by the students of the concerned batch. INPHB provides 350 € per person and ESIGELEC provides 650 € per person. The final results for the candidates are assessed and approved by the Joint Management Committee of the MSc programme.