

Partager



Email destinataire :

Vous devez renseigner un email valide

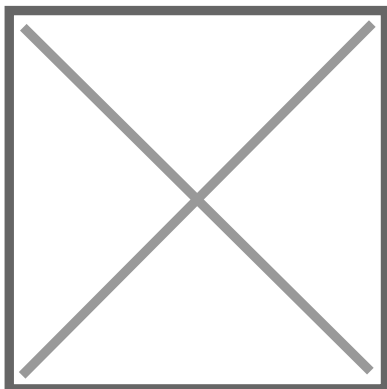
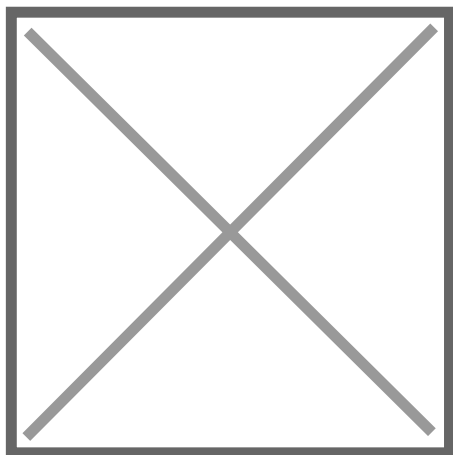
Envoyer

Une erreur est survenue. Merci de réessayer ultérieurement

Le mail de partage a bien été envoyé.

Ajouter au comparateur

M2 Systèmes avancés de Radiocommunication (SAR)



Master

Mention Electronique, Energie Electrique, Automatique

Régime(s) d'inscription

Formation initiale

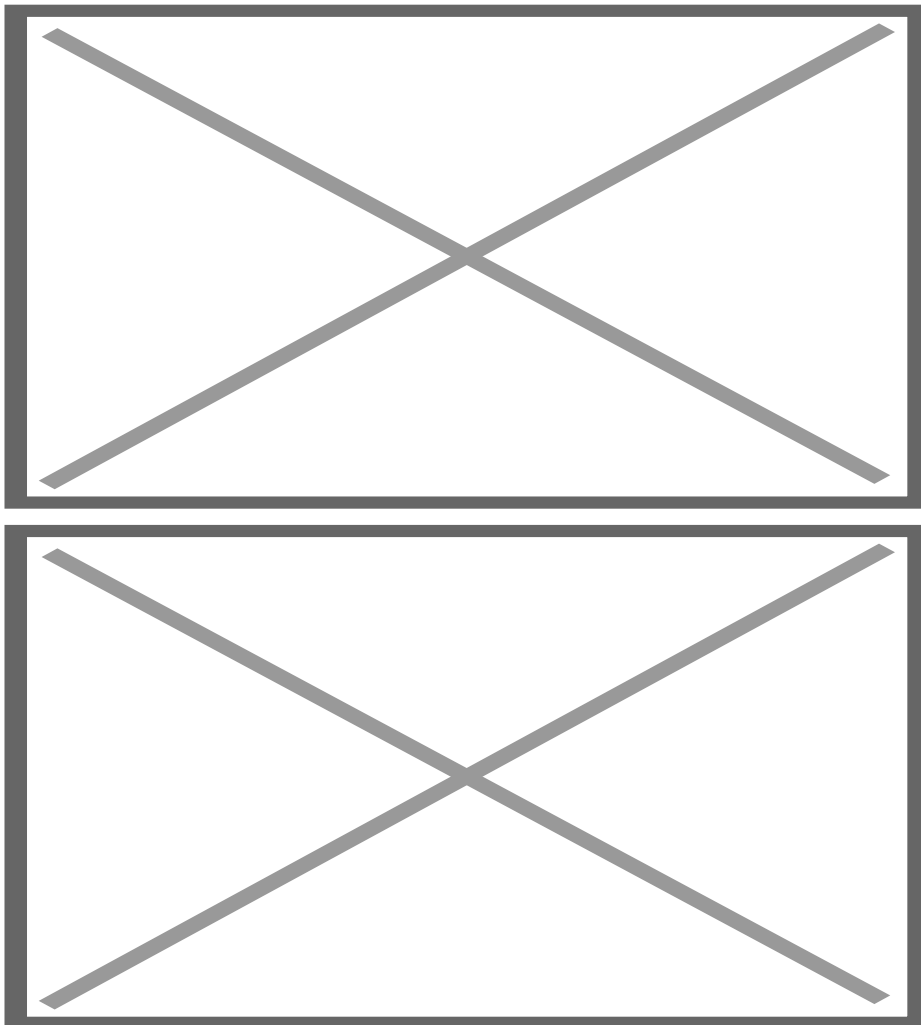
Langue(s) d'enseignement

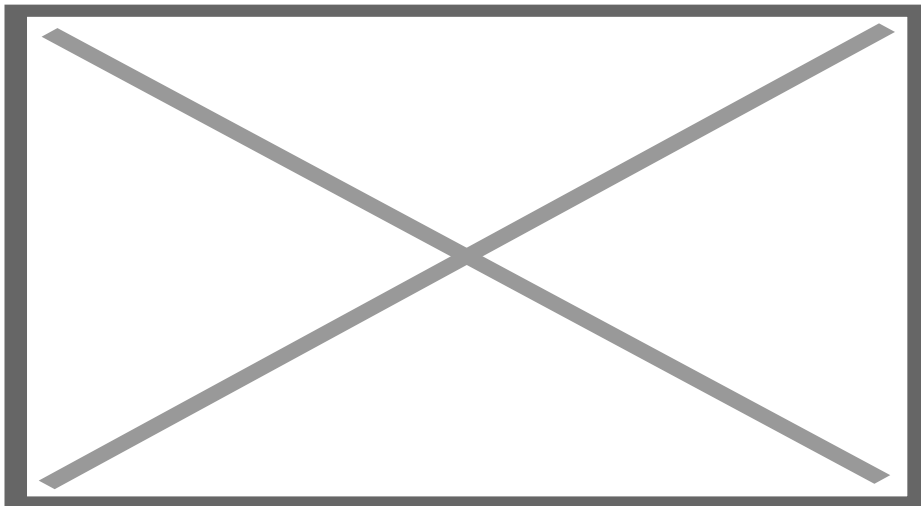
Anglais

The Master Program AWCS (SAR) is a research-oriented Master degree, that corresponds to the second year of the 2-year European Master degree curriculum. conducted entirely in English, this program provides a rigorous foundation in wireless communications, machine learning, and networking. Its primary goal is to equip students with the deep theoretical knowledge and practical skills required for a successful career in research and development.

The curriculum provides a wide-ranging education, spanning the disciplines of information theory, coding, communication and networking theory, and machine learning—with a focus on statistical learning, reinforcement learning, deep learning, and large language models (LLMs). The instructors are internationally-renowned researchers in their field. The curriculum is structured in three progressive phases: a Foundational Core of fundamental courses, a Research Immersion involving advanced seminars and a hands-on project, and a culminating Internship with an industrial or academic partner, either in France or abroad.

[Télécharger la fiche détaillée](#)
[Je candidate](#)





■ ■

Informations

- [Présentation](#)
- [Admission](#)
- [Programme](#)

Présentation

Compétences

Courses focus on the theoretical and fundamental methodologies and techniques, which are necessary for understanding key advances in the areas of wireless communications, machine learning and networking.

The career of M2R SAR graduates could be oriented towards all sectors of telecommunications and machine learning. They could work in higher education institutions and universities, in public (CNRS, INRIA, CEA, etc.) and private research sector (industrial research and development departments) and in any company requiring deep understanding and rigorous scientific reasoning (project managers, research directors, etc.). A survey about the first employment of former students has shown that they find very shortly after their graduation either funding for pursuing a PhD thesis (CIFRE, doctoral contracts, public grants and scholarships) or a permanent position in a company

The M2 SAR has an extended network of industrial partners, including Nokia, Ericsson, Orange Labs, Qualcomm, Thales Communications, TCL, EDF, CEA, Mitsubishi Electric, SEQUANS Communications, etc. Many students join the above companies for their research internship.

Objectifs pédagogiques de la formation

This cross-disciplinary program aims to convey solid fundamental knowledge in the field of wireless communications, machine learning, and networking as a means to prepare the students for their future professional careers. The curriculum spans a large spectrum of material, ranging from information theory and coding to communication theory, networking theory and machine learning (statistical and reinforcement learning, Deep learning, LLM).

The academic year is structured as follows:

- September - February: The academic year begins with foundational courses, where students build a strong background in essential mathematical tools and machine learning. This foundation supports subsequent specialized courses in wireless communication and networking, which provide the key concepts needed for advanced research.
- January - March: the focus shifts to research immersion. Students participate in seminars on advanced topics and begin developing their own research project.
- Finally, from April onward, students undertake a full-time internship for at least four months, in companies or academic institutions, either in France or internationally.

Débouchés

Poursuite d'études

Doctorat

domaines de l'apprentissage statistique, de l'intelligence artificielle ou de l'analyse de données avancée

Ingénierie études, recherche et développement

Les étudiants de cette mention peuvent se tourner vers la recherche à l'issue du M2

Les étudiants titulaires d'un M2 ont la possibilité de poursuivre dans la recherche en doctorat

Admission

Voie d'accès

Informatique

Mathématiques

Physique

Electronique, énergie électrique, automatique

Sciences et technologies

Sciences pour l'ingénieur

Capacité d'accueil

Places

15

Public visé et prérequis

-Students having an M1 (i.e. first year of the two-year European Master degree curriculum) in Electrical Engineering and related fields (e.g. Telecommunications, Electronics, etc.).

-Students having an M1 in mathematics, Physics, or Computer Science

-Students having a Bachelor of Engineering (BE) in Electrical Engineering and related field.

-Engineering students can attend this master program in parallel to the last year of their engineering curriculum

Période(s) de candidature

Plateforme Inception

Du 21/01/2026 au 30/06/2026

Pièces justificatives

Obligatoires

Lettre de motivation.

Lettre de recommandation ou évaluation de stage.

Tous les relevés de notes des années/semestres validés depuis le BAC à la date de la candidature.

Curriculum Vitae.

Descriptif détaillé et volume horaire des enseignements suivis depuis le début du cursus universitaire.

Facultatives

Attestation de niveau d'anglais (obligatoire pour les non anglophones).

Dossier VAPP (obligatoire pour toutes les personnes demandant une validation des acquis pour accéder à la formation) <https://www.universite-paris-saclay.fr/formation/formation-continue/validation-des-acquis-de-lexpérience>.

Fiche de choix de M2 (obligatoire pour les candidats inscrits en M1 à l'Université Paris-Saclay) à télécharger sur <https://urlz.fr/i3Lo>.

Document justificatif des candidats exilés ayant un statut de réfugié, protection subsidiaire ou protection temporaire en France ou à l'étranger (facultatif mais recommandé, un seul document à fournir) :

- Carte de séjour mention réfugié du pays du premier asile
- OU récépissé mention réfugié du pays du premier asile
- OU document du Haut Commissariat des Nations unies pour les réfugiés reconnaissant le statut de réfugié
- OU récépissé mention réfugié délivré en France
- OU carte de séjour avec mention réfugié délivré en France
- OU document faisant état du statut de bénéficiaire de la protection subsidiaire en France ou à l'étranger.

Programme

Mathematical and Machine Learning Tools

[illegible]

Foundations of Deep Learning

ECTS : 3

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

Course outline

- Introduction to Neural Networks: Perceptrons, capacity of a single neuron, Linear and logistic regression, etc.
- Approximation with neural networks, Barron's theorem
- Training of neural networks, Generalization, Rademacher complexity
- Various Neural Networks architectures (RNN, CNN, etc.)
- Example of modern architectural variations for communications.

Objectifs d'apprentissage

This is a course on the principles of representation learning in general and deep learning in particular. Deep learning has recently been responsible for a large number of impressive empirical gains across a wide array of applications including most dramatically in object recognition and detection in images, natural language processing and speech recognition.

This course explores recent theories that explain the empirical success of deep learning. Furthermore, advanced neural networks architectures (RNN, CNN, etc.) will be explained and implementation using Python will be discussed.

Organisation générale et modalités pédagogiques

This course is composed of 6 lectures (18h) and two lab sessions (6h).

Bibliographie

1. Deep Learning, by Ian Goodfellow, Yoshua Bengio and Aaron Courville, Adaptive Computation and Machine Learning series, MIT Press, November 2016, ISBN-10: 0262035618.

2. Machine Learning: A Probabilistic Perspective, by

[illegible]



Statistical and Reinforcement Learning

ECTS : 3

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

probability, statistics, optimisation

Programme / plan / contenus

I Statistical Learning

- Framework, empirical risk minimisation, overfitting
- Algorithms: gradient descent, stochastic gradient descent
- Statistical models: linear classification/regression, kernel methods, neural networks

II Reinforcement Learning I

- Multi-Armed Bandits (MAB)
- Algorithms for stochastic MABs: UCB, KL-UCB, Thompson Sampling
- Algorithms for adversarial MABs: Hedge, EXP3.

III Reinforcement learning II

- Basic algorithms: Q-Learning, SARSA
- Algorithms for large scale problems: value approximation, policy gradient.
- Monte-Carlo tree search and the UCT algorithm.

IV Application of Learning in Wireless Networks

- Example of wireless networking problems where Reinforcement Learning is applied.
- Examples of Implementation using Matlab, Python.

Objectifs d'apprentissage

The goal of this course is to provide students with an introduction to the field of machine learning, with a particular focus on online learning. In the first part we will review statistical learning theory, and provide efficient algorithms for regression and classification. In the second part, we will focus on reinforcement learning which enables to solve Markov Decision Processes (MDPs) when the statistics of the environment are unknown. We will first consider algorithms for Multi-Armed Bandits (i.e. MDPs with a single state), and then extend our approach to general MDPs. Approximation techniques for large scale problems will also be addressed. Applications in the context of wireless networks will be discussed.

[illegible]

Mathematical Basis for Communication and Learning

ECTS : 4

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Programme / plan / contenus

Part I

- Introduction to probabilities on events.
- Probabilities on a finite or countable space
- Random variables on continuous space ($\mathbb{R}$). Independent random variables and characteristic functions.
- Multivariate distributions (Gaussian distribution).
- Different convergences (Central Limit Theorem and the Laws of Large Number).
- Introduction to parameter estimation and confidence areas
- Concept of sufficient statistics
- UMVU (Uniformly Minimum-Variance Unbiased) estimators
- Cramér-Rao bound, Fisher information
- Maximum Likelihood estimator, asymptotic efficiency
- Bayesian estimators (MMSE, L1 Norm, MAP)
- Posterior Cramér-Rao bound
- Detection: Neyman-Pearson lemma
- Bayesian detection.

Part II

- Review of fundamental notions of set theory and topology
- Unconstrained optimization
- Constrained optimization
- KKT conditions
- The important case of convex optimization, global optimality, duality principle
- A short note on optimization in dynamical systems: the dynamic programming principle (Viterbi algorithm example), HJB equation
- Numerical methods for optimum design
- Distributed optimization in communication networks
- Basic notions of games and learning

Objectifs d'apprentissage

The aim of the first part of this course is refreshing basic notions in probability theory and providing students with

Fundamentals of Communication and Networking

[illegible]

Network Architectures and Performance

ECTS : 6

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Basics of Communication Networking, Probability, Markov Chains

Programme / plan / contenus

Course outline:

- Background of wireless and mobile communication networks. Physical and MAC Standards.
- Introduction to Networks
 - Packet Switching Models
 - Architecture, layers, protocols
- Fundamentals of Internet
 - Networking : IPv4 and v6 protocols, Addressing, Relaying, Routing
 - TCP : Reliability, Congestion Control
 - Applications and Services
- Multimedia
 - Multimedia and streaming applications
 - Multicast
 - Quality of Service in Internet
- Future Internet
 - Naming, addressing
 - Software Defined Networking
 - Network Function Virtualization.
- Mobile Networking
 - Mobile IP and Mobility Management Protocols
 - TCP over Wireless and Mobile Networks
 - Cross layer approaches
- Traffic engineering in Mobile networks
 - Review of queuing theory models
 - Application to network capacity estimation

[illegible]

Foundations of Wireless Communications

ECTS : 6

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Information theory, Linear Algebra, Estimation Theory, Probability Theory, Optimization tools

Programme / plan / contenus

Course Outline

Part I: Single antenna Systems

- Overview of deterministic signals: Signals as vectors, geometry of linear spaces, expansions and transforms, etc.
- Digital modulations: Linear modulations, constant envelop modulations, mapping.
- Detection and equalization in single-carrier systems: Maximum Likelihood Sequence Estimation for linear AWGN channels. Sub-optimal equalization: Linear equalization (ZF, MMSE), Decision-Feedback Equalization (DFE), Decision-Feedback Sequence Estimation (DFSE).
- Digital communications through fading (multipath) channels: The concept of diversity (frequency, time and spatial diversity), performance analysis.

Part II : Multi-antenna systems

- Capacity and outage of wireless channels
- Diversity and multiplexing, space-time codes
- Receiver architecture: maximum likelihood detection, linear detection, successive interference cancellation (SIC)
- Multiple access channel (uplink) : capacity region, SIC
- Broadcast channel (downlink) : capacity region, dirty paper coding, beamforming
- Other networks: interference channels, relay channels, network MIMO, massive MIMO.

-Part III: Multiple Access Techniques

- Overview of multiple access techniques (TDMA, OFDMA, NOMA, etc.)
- Design and challenges of Power control in wireless

[illegible]

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
■											

Information and Coding Theory

ECTS : 6

Semestre calendaire : Semestre 1

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Analysis, linear algebra and probability at undergraduate level

Programme / plan / contenus

COURSE OUTLINE

Part I

1. Properties of Shannon's Information Measures

2. Markov Chain, Fundamental Inequalities and Entropy of Stationary Sources

3. Lossless Source Coding

Weak Typical Sequences, Noiseless Source Coding and its Coding Theorem,

4. Method of Types

Type Counting Lemma, Strong Typical Sets, Delta Sequences, etc.

5. Coding Theorem for Noisy Channels (Binary Symmetric Channels, Gaussian Channels (AWGN), etc.)

6. Coding Theorem for Lossy Source Coding

7. Converse to the Coding Theorems for Discrete Memoryless Sources (DMSs) and Channels (DMCs)

8. Capacity of Wireless Channels

Channels with Colored Gaussian Noise and Fading, Channels with Multiple Antennas (MIMO) and Fading, etc.

Part II :

1-Introduction to error-correcting codes

2-Linear cyclic codes

3-Linear convolutional codes

4-Performance of linear codes under MLD

5-Factor graphs and the sum-product algorithm

6-Sparse-graph codes

7-Sparse-graph codes

8- Sparse-graph codes

Internship

Matières	ECTS	Semestre	Cours	TD	TP	Cours-TD	Cours-TP	TD-TP	A distance	Projet	Tutorat
Internship	20	Semestre 2									

Internship

ECTS : 20

Semestre calendaire : Semestre 2

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

Research Project

Matières	ECTS	Semestre	Cours	TD	TP	Cours-TD	Cours-TP	TD-TP	A distance	Projet	Tutorat
Research Project	6	Semestre 2									

Research Project

ECTS : 6

Semestre calendaire : Semestre 2

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Wireless communications, networking, Machine Learning, etc.

Objectifs d'apprentissage

The students work on research projects proposed by the academic staff involved in the master program. The topics of the projects are related to the research activities of the instructors. The topics can cover different aspects of machine learning and wireless communications and networking.

Bibliographie

Recent papers in the domain.

Nature de l'évaluation

Evaluation Continue non Intégrale

Advanced Elective courses

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
UE libre	2	Semestre 2	12								
■											

UE libre

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

Multimedia Compression	2	Semestre 2	12
--	---	---------------	----

■

Multimedia Compression

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

Satellite Communications	2	Semestre 2	12
--	---	---------------	----

■

Satellite Communications

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

Matières	ECTS	Semestre	Cours	TD	TP	Cours- TD	Cours- TP	TD- TP	A distance	Projet	Tutorat
Introduction to 6G	2	Semestre 2	12								
■											

Introduction to 6G

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Nature de l'évaluation

Evaluation Continue non Intégrale

[Large Language Models
\(LLM\) in Communication
and Networking](#) 2 Semestre
2 12

■

Large Language Models (LLM) in Communication and Networking

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Deep Learning, Optimization, probability

Nature de l'évaluation

Evaluation Continue non Intégrale

[Quantum Information
Theory](#) 2 Semestre
2 12

Quantum Information Theory

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

Information Theory

Nature de l'évaluation

Evaluation Continue non Intégrale

Reconfigurable Intelligent Metasurfaces	2	Semestre	12
		2	

Reconfigurable Intelligent Metasurfaces

ECTS : 2

Semestre calendaire : Semestre 2

Détail du volume horaire

Cours magistraux : 12

Langue d'enseignement

Anglais

Enseignement à distance

non

Prérequis

wireless communications, probability, Linear Algebra

Nature de l'évaluation

Evaluation Continue non Intégrale

Lieu(x) d'enseignement

GIF SUR YVETTE

Contact(s)

•

Mohamad ASSAAD

PR

•

CentraleSupélec SUPPORT SCOLARITE

Support scolarité

<http://www.universite-paris-saclay.fr/formation/master/electronique-energie-electrique-automatique/m2-systemes-avances-de-radiocommunication-sar>