
MASTER OF SCIENCE, TECHNOLOGY AND HEALTH

2024-2025

YEAR 2

MARINE TECHNOLOGY

ATLANTIC MASTER ON SHIP OPERATION
AND NAVAL ENGINEERING (AMASONE)

PROGRAMME SUPERVISOR(S):

Antoine DUCOIN



Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

CORE COURSES

Course code	Title	ECTS Credits
ACOUST	Acoustics	3
CONF	Conferences	-
HYDRA	Hydrodynamics (advanced)	4
HYDROEN	Hydrodynamics (basics)	3
KNFLU	Knowledge of Marine Environment	4
LABHY	Labs in Hydrodynamics	4
MAENV	Maritime initiation and Leadership	4
PROPEL	Electric Propulsion	2
TROSH	Training on Ship	4

LANGUAGE COURSES

Course code	Title	ECTS Credits
CCE3	Cultural and Communication English	2
ESP3	Spanish Language	2
FLE3	French Language	2

YEAR 2 - Spring Semester

CORE COURSES

Course code	Title	ECTS Credits
THESIS	Master Thesis or Internship	30

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Acoustics [ACOUST]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

This course has two main objectives:

- 1) to understand the senses of a ship: how the sailors can evaluate the ship environment remotely. It covers all the sensors (optical, radio, radar, sonar) all sensors are faced to extracting a useful information (signal) spoiled by spurious information (noise).
- 2) After a description of the ocean and the seafloor, a deep study of underwater acoustics and sonar systems is achieved in order to show how they can be used for evaluation the underwater environment.

Course contents

- 1) Senses of a ship, a unified approach: optical, electromagnetic (radar, communication) & acoustical sensing: (3 h)
- 2) Arrays, antenna, beamforming and Fourier transform (3 h)
- 3) Understanding the Ocean: overview of oceanography and marine geosciences (2 h)
- 4) Ocean variability and its influence on acoustical propagation (3 h)
- 5) Sonar Systems (4 h)
- 6) An example of sonar systems: sidescan sonar (3 h)
- 7) Sonar transducers (2 h)
- 8) Acoustic propagation in the Ocean (4 h)
- 9) Characteristic of noises at sea (2 h)
- 10) Active sonar equation and active systems analysis (6 h)
- 11) Conventional signal processing schemes (4 h)
- 12) Hands on: side scan sonar, training at sea (3 h)

Course material

Principles of underwater sounds by R. J. Urick, Paninsula Publishing 2013

Principles of Radar and Sonar Signal Processing, by François le Chevalier, Artech House Publishers 2002.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	40 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Conferences [CONF]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

This course is devoted to general conferences that may be given during the year.

Course contents

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	-	20 hrs	0 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Hydrodynamics (advanced) [HYDRA]

LEAD PROFESSOR(S): Antoine DUCOIN / Jean-Yves BILLARD

Requirements

Objectives

To give knowledge in advances hydrodynamics

Course contents

Description of the ship design process

Design of a ship using a naval architecture software

Study of international regulations

Study of the propulsion system

During this two-week internship the student puts into practice the teachings received during the beginning of training. The work is carried out by two or three students who develop the preliminary design of a service vessel meeting the criteria imposed by international regulations.

Course material

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	15 hrs	0 hrs	0 hrs	40 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Hydrodynamics (basics) [HYDROEN]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

The purpose of this course is to provide clear connections between modern naval engineering and classic hydrodynamics by developing theoretical and practical skills.

Course contents

Organized into four sections, the course insist on exercising a specific skill-set related to each section as described next.
 Section 1: A practical exercise based on DelftShip [A] animates the discussion to understand hull geometry : ship dimensions, form coefficients, ship lines [1] and its uses from an engineering point of view by simultaneously describing empirical procedures for preliminary estimations of the powering requirements of a vessel [2]. The section concludes with a seminar during which students present their work on using Delftship and their bibliographical research (orchestrated by specific reading material) to demonstrate design particularities related to hull geometry of certain vessel categories: tankers-containers, service vessels, high-speed vessels and special categories and conclude with powering estimations of a vessel of their category.

Section 2: Having related hull's geometry and resistance from a global point of view the need of calculating fluid stress on the hull's surface to evaluate resistance is our principal motivation for introducing the incompressible Navier-Stokes equations in a modern tensorial formulation [3]. The section concludes with a seminar during which students present their work (orchestrated by specific reading material) on using the tensorial framework to formulate classic solutions of the Navier-Stokes [4]: Hagen-Poiseuille flow, Couette flow, 1st and 2nd Stokes problem, 1D linear wave theory and Blasius solution for boundary layers, and use them as a motivating mean to describe hydrodynamics concepts [5]: vortical patterns for different Reynolds numbers, transition concepts, ship-generated waves, viscous components of resistance.

Section 3: The need for numerical estimations for engineering problems is naturally introduced by understanding the underlying difficulties of solving the Navier-Stokes even for problems of simple geometries. Classic numerical approximation methods are introduced for lift-generating flows: D'Alambert paradox, Magnus effect, relating vorticity/lift, to eventually generalize these concepts to simple panel methods for 2D hydrofoils and Prandtl's lifting line [6]. Using the developed concepts the students use OpenProp [B] to understand propeller geometry and performance coefficients.

Section 4: Bibliographical research is conducted by the students to collect material related to naval hydrodynamics so that they can assess the modern world of naval engineering and research related to industrial needs. The students present their work during the course's last seminar. The students begin by revisiting the research work of LHEEA and IRENAV (experimental and numerical) to clarify the connections between the participating institutions of AMASONE and modern developments in naval engineering.

Course material

[1] Letcher (2009), The Principles of Naval Architecture Series: The Geometry of Ships, SNAME.

[2] Larsson & Raven (2010), The Principles of Naval Architecture Series: Ship Resistance and Flow (ch.10), SNAME.

[3] Hjelmstad (2005), Fundamentals of Structural Mechanics, Springer.

[4] Panton (2005), Incompressible Flow (3rd ed.), Wiley.

[5] Newman (1999), Marine Hydrodynamics (9th ed.), MIT Press.

[6] Katz, J., & Plotkin, A. (2010). Low-Speed Aerodynamics (2nd ed.). Cambridge University Press.

Online resources

[A] <https://www.delftship.net/DELFTwp/>

[B] <https://engineering.dartmouth.edu/openprop/>

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	3	0 hrs	20 hrs	20 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Knowledge of Marine Environment [KNFLU]

LEAD PROFESSOR(S): Antoine DUCOIN / Jean-Yves BILLARD

Requirements

Objectives

This course has two main objectives:

- 1) to gain a better knowledge of the physics of the ocean, of marine geosciences, and of underwater acoustics,
- 2) to understand the principles of the systems that provide information on the ocean and on the seafloor.

Course contents

- 1) Overview of oceanography and marine geosciences (2 h)
- 2) Overview of acoustics and underwater acoustics, sonar equation, underwater acoustics propagation (5h)
- 3) Tools and methodology for seafloor observation. Principles of bathymetry (3h)
- 4) Principles of multibeam echosounders and side scan sonar, including training at sea (3h)
- 5) Bathymetry with processing of real data (3h)
- 6) Analysis of various underwater acoustics systems (5h)
- 7) Evaluation, prevention and control of exposure to noise at the workplace.

Course material

X. Lurton, An introduction to underwater acoustics, 2nd edition, Springer, 2010.

F. Jensen, W. Kuperman, M. Porter, H. Schmidt, Computational Ocean Acoustics, 2nd edition, Springer, 2011

K. Pickering and R. Hiscott, Deep Marine Systems: Processes, Deposits, Environments, Tectonics and Sedimentation, Ed.: Wiley-blackwell - 2015

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	40 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Labs in Hydrodynamics [LABHY]

LEAD PROFESSOR(S): Antoine DUCOIN / Félicien BONNEFOY

Requirements

Fluid Mechanics
Water Waves and Sea State Modeling
Wave-Structure Interaction

Objectives

The objective of this course is to get practical knowledge in the field of hydrodynamics through a series of labwork in the experimental basin at Centrale Nantes

Course contents

Program:

labwork 1 : experiments in ocean wave basin, wave-structure interaction of a floating marine structure

labwork 2: experiments in towing tank, wave resistance of a ship

labwork 3: experiments in flume test facility, performance of a marine propeller in open water condition

labwork 4: ship stability experiments

Course material

- S.A. Hughes, Physical Models and Laboratory Techniques in Coastal Engineering
- N. Newman, Marine Hydrodynamics
- O.M. Faltinsen, Sea loads on ships and offshore structures
- V. Bertram, Practical Hydrodynamics
- S. Chakrabarti, Offshore structure modelling

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	0 hrs	24 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Maritime initiation and Leadership [MAENV]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

The aim of the practical leadership training is to introduce the students to 'leadership' from a military perspective in both the land and maritime environments. The focus is action centered putting the students in command situations requiring them to develop a plan of action and brief their intentions in a coherent and structured manner.

Course contents

The course will start with classroom theory, giving the students time to understand the foundations to leadership in a military domain; it will also include question and answer time. The course has a secondary focus on team work and cohesion as a key to effective output; and as such the course will include various activities which will highlight their necessity and relevance. The students will take command of a team for a mission in the land and maritime environments. By the end of the course the students should be able to deliver a briefing following the basic NATO structure of orders and also take charge of a team understanding the importance of different leadership styles and techniques to get the most out of their team.

- Leadership
- Physical Training
- Ethics
- Maritime History
- Geopolitics
- Maritime English
- 1 day on a boat (Goelette)

Course material

Adair, J (2002) Inspiring Leadership. London: Thorogood
 Northhouse P.G. (2009) Leadership Theory and Practice. London: Sage Publications
 Yukl, G. (2002) Leadership in Organisations, 5th edn. New Jersey: Prentice Hall.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	0 hrs	60 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Electric Propulsion [PROPEL]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

- To give a knowledge of the possible architectures of all electric ship or hybrid electric ship
- To give a knowledge of the pros and cons of electrical propulsions
- To give a knowledge of the architecture and the behavior of the most common systems used in electrical and hybrid-electric propulsion systems for ships.
- To give some elements on electrical embedded networks for ships.
- To give an overview of the future solutions

Course contents

- 1) Interest of Electric or Hybrid Systems for Ship Propulsion Application
- 2) Variable speed propulsion systems
 - 2-1) Systems based on Rectifiers with DC motors (old historical solution)
 - 2-2) Systems based on CSI and synchronous AC motors
 - 2-3) Systems based on VSI and AC Motors
 - 2-4) Evolution of variable speed propulsion systems
- 3) Power electronics and networks
 - 3-1) Harmonics in AC Grid
 - 3-2) DC Networks
- 4) Future solutions

Course material

- Damir Radan : Power Electronic Converters For Ship Propulsion Electric Motors, Tech. Report, Department of Marine Technology, project: Energy-Efficient All Electric Ship, NTNU, Trondheim, Norway, 2004
- IEEE Guide for the Design and Application of Power Electronics in Electrical Power Systems on Ships, IEEE-2008
- Alf Kåre Ådnanes : Maritime Electrical Installations And Diesel Electric Propulsion –Report ABB 2003

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	20 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Training on Ship [TROSH]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

To develop security, navigation and maneuver fundamentals.
To enhance seamanship through maneuver practice at sea and navigation at sea

Course contents

- Basic security training.
- Navigation training on bridge simulator.
- Basic maneuver training at sea (rhib, motor boats).
- Navigation aboard French Navy training units

- Navigation Simulator : CC Loïc Moller
- Security : LV Emilie Guiho
- Personal Rescue Techniques : LV Sylvain Frappier
- Training on "Zodiac" : CC Patrice L'Hour
- Training on Ship : CC L'Hour with other officers

Course material

Code Vagnon permis de plaisance par A. Nemeta (Ed. Vagnon)
 Traité Vagnon de navigation par C. Lorieux (Ed. Vagnon)
 Guide de manœuvre de l'Ecole navale (impr. Ecole navale)
 Traité de manœuvre par Hervé Baudu (Ed. InfoMer)

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	4	20 hrs	0 hrs	0 hrs	48 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Cultural and Communication English [CCE3]

LEAD PROFESSOR(S): David TROYA

Requirements

Objectives

- Understand the fundamental principles of scientific writing and the importance of clarity and precision in communication.
- Structure scientific documents effectively, adhering to genre-specific conventions.
- Employ appropriate language and tone for diverse scientific audiences.
- Integrate and cite sources correctly to support research arguments and findings.
- Edit and revise their writing for coherence, style, and grammatical accuracy.
- Prepare and deliver scientific presentations, both written and oral.

Course contents

Introduction to Scientific Writing

Overview:

This course provides an essential foundation in scientific writing, equipping students with the skills necessary to effectively communicate research findings and scientific concepts. Through a combination of lectures, workshops, and practical assignments, students will learn the conventions of scientific writing, including structure, style, and clarity. The course will cover various types of scientific documents, such as research papers, literature reviews, grant proposals, and poster presentations.

Course Structure:

The course will be organized into weekly sessions that include lectures on theoretical concepts, hands-on writing exercises, peer review workshops, and discussions of exemplary scientific literature. Students will engage in collaborative projects and receive constructive feedback to enhance their writing skills.

Assessment:

Students will be assessed through a combination of assignments, including written documents, peer review participation, and presentations. Active participation in workshops and discussions is also required to foster a collaborative learning environment.

Course material

Hoogenboom BJ, Manske RC. How to write a scientific article. *Int J Sports Phys Ther.* 2012 Oct;7(5):512-7. PMID: 23091783; PMCID: PMC3474301.

Paré G, Kitsiou S. Chapter 9 Methods for Literature Reviews. In: Lau F, Kuziemy C, editors. *Handbook of eHealth Evaluation: An Evidence-based Approach* [Internet]. Victoria (BC): University of Victoria; 2017 Feb 27. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK481583/>

How to Create a Research Poster. A guide fo creating a research poster. <https://guides.nyu.edu/posters>

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

Spanish Language [ESP3]

LEAD PROFESSOR(S): Marta HERRERA

Requirements

N/A

Objectives

For beginners:

Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)

Acquisition of vocabulary and linguistic structures

Be able to talk about yourself and those around you

Be able to express oneself during daily activities

Know how to give your opinion

For advanced students:

Practice and reinforcement of the five skills (oral and written expression and comprehension as well as interaction)

Acquisition of specialised vocabulary

Be able to understand the essential content of concrete or abstract subjects including a technical discussion

Be able to communicate spontaneously and fluently

Be able to express oneself in a clear and detailed manner, to express an opinion on a topical subject

Course contents

For beginners:

Personal environment (introduce yourself, express yourself, your tastes, your character, your hobbies, etc.), your surroundings (friends, family, location, climate), your interests (sports, leisure)

Present tense (regular and irregular)

Language patterns to express habit, obligation, "gustar" and its equivalents,

Possessive adjectives

Differences between "es", "está", "hay"

Use of "por" and "para"

Adverbs and frequency patterns

Numeral adjectives

For advanced students:

Knowledge of the Hispanic world (economic, technical, cultural and social environment)

Present tense (regular and irregular)

Imperative

Past tenses

Direct / indirect style

Future tense

Conditional tense

Present and past subjunctive moods

Course material

Preparation manuals, our own tailor-made documents, written and internet press, general civilization documents, digital tools

Assessment

Individual assessment: EVI 1 (coefficient 1)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
Spanish	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Autumn Semester

French Language [FLE3]

LEAD PROFESSOR(S): *Silvia ERTL*

Requirements

N/A

Objectives

The objective is to familiarize the learner with the French language and French culture through an entertaining task-based communicative language teaching, focused on speaking combined with:

- Phonetics
- Self-correcting exercises on our learning platform
- Learning Lab activities
- Project work
- Tutoring

Course objectives include the acquisition and reinforcement of vocabulary, syntax, and pronunciation by both traditional means and through the use of digital resources. Students will learn general French, develop language skills of oral and written comprehension and expression.

After completing this course (32 hours + personal work), the students will be able to communicate in spoken and written French, in a simple, but clear manner, on familiar topics in the context of study, hobbies etc. Another important goal of this course is to introduce the student to French culture.

At the end of the course, complete beginners can achieve an A1 level and some aspects of the A2 of The Common European Framework of Reference for Languages. More advanced students may aim for B1/B2 levels. Those who already completed the first year of the French course will be prepared for working in a French business environment.

Course contents

Two different tracks are proposed: track 1 for students newly arrived at Centrale Nantes and track 2 for students who have completed the first year of the French course. Track 1:

Full range of practical communication language exercises: reading comprehension, listening comprehension, written expression, oral expression.

Learners will be able to use the foreign language in a simple way for the following purposes:

1. Giving and obtaining factual information:

- personal information (e.g. name, address, place of origin, date of birth, education, occupation)
- non-personal information (e.g. about places and how to get there, time of day, various facilities and services, rules and regulations, opening hours, where and what to eat, etc.)

2. Establishing and maintaining social and professional contacts, particularly:

- meeting people and making acquaintances
- extending invitations and reacting to being invited
- proposing/arranging a course of action
- exchanging information, views, feelings, wishes, concerning matters of common interest, particularly those relating to personal life and circumstances, living conditions and environment, educational/occupational activities and interests, leisure activities and social life

3. Carrying out certain transactions:

- making arrangements (planning, tickets, reservations, etc.) for travel, accommodation, appointments, leisure activities
- making purchases
- ordering food and drink

Track 2:

This track follows on directly from the first-year French course, developing and completing the concepts studied thus far. The main themes are: housing, health and work. These topics will help prepare students for their future work environment. For example, housing is explored in the form of a search for accommodation upon arrival in a new city. Special workshops for CVs and cover letters, elevator pitches and job interviews.

Course material

Preparation manuals, our own tailor-made documents, written and televised press, internet, general civilization documents, digital tools, our own educational materials on Hippocampus (Moodle).

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	2	0 hrs	32 hrs	0 hrs	0 hrs	0 hrs

Master Programme - Marine Technology - Atlantic Master on Ship Operation and Naval Engineering (AMASONE)

YEAR 2 - Spring Semester

Master Thesis or Internship [THESIS]

LEAD PROFESSOR(S): Antoine DUCOIN

Requirements

Objectives

- Be exposed to and adapt to an industrial or research environment
- Put in practice the scientific and technical skills acquired in the previous semesters
- Strengthen interpersonal and communication skills
- Be part of or manage a project
- Organize tasks, analyze results and build deliverables

Course contents

Students should be pro-active and career-oriented in the search for their thesis/internship. The topics are validated by the program supervisor to ensure an adequate Master level. The thesis/internship is evaluated through the submission of a written report and an oral defense.

Course material

- Turabian Kate Larimore, Booth Wayne Clayton, Colomb Gregory G., Williams Joseph M., & University of Chicago press. (2013). A manual for writers of research papers, theses, and dissertations: Chicago style for students and researchers (8th edition.). Chicago (Ill.) London: University of Chicago Press.
- Bui Yvonne N. How to Write a Master's Thesis. 2nd ed. Thousand Oaks, Calif: Sage, 2014.
- Evans David G., Gruba Paul, et Zobel Justin. How to Write a Better Thesis. 3rd edition. Carlton South, Vic: Melbourne University Press, 2011.

Assessment

Individual assessment: EVI 1 (coefficient 1.0)

LANGUAGE OF INSTRUCTION	ECTS CREDITS	LECTURES	TUTORIALS	LAB	PROJECT	EXAM
English	30	0 hrs	0 hrs	0 hrs	0 hrs	0 hrs