Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering In Marine Engineering

(Syllabus)

ENIDH, Fevereiro de 2012

Master of Engineering in Marine Engineering

1st Year

	CH	ECTS		CH	ECTS
Propulsion Plants	4	5	Energy Analysis of Marine Systems	4	5
Instrumentation and Control	4	5	Syst. and Electrical Installations of Ships	4	5
Fracture Mechanics and Fatigue	4	5	Condition Control	4	5
Hydrodynamics and Propulsion	4	5	Refrigeration and Air Conditioning	4	5
Regulations and Maritime Law	4	5	Ship Management	4	5
Optional unit (M1):			**Optional unit (M2):**		
Welding in Marine Construction	4	5	Composite Materials	4	5
Systems Modelling and Simulation	4	5	Tanker Ships	4	5
Thermal Equipment	4	5	Robotics and Automation	4	5
Digital Systems and Microprocessors	4	5	Applications with Microprocessors	4	5
Advanced Health Care	4	5			
Totals	**24**	**30**	Totals	**24**	**30**

2nd Year

	Annual unit	ECTS
Dissertation / Project / Report		**60**

NOTES:
(*) – Optional unit. The student chooses one from two units.
CH – Contact Hours per week
TH – Tutorial orientation Hours per week
ECTS – European Credit Transfer System

MARITIME CERTIFICATION

1. Successful completion of the Specialization Course in Marine Engineering (first year of the MSc course in Marine Engineering), meets the minimum requirements for obtaining certificates of competence for chief engineer officers and second engineer officers in vessels whose main propulsion power is equal or higher than 3000 kW, as provided in paragraph 2.2 of Regulation A-III/2 of the Annex to the STCW Convention of 1978 as amended in 1995 and provided in Decree No. 280/2001, October 23 as amended by Decree N.º 206/2005 of 29 November and by Decree N.º 226/2007 of 31 May, thereby enabling to obtain the relevant certificates of competence, considering that are satisfied the remaining requirements for certification.

2. The successful completion of the mandatory course unit "Regulations and Maritime Law", meets the mandatory requirements for obtaining the certificate of "Crisis management and human behaviour", in accordance with Section A-V/2 and A-V/3, paragraphs 1, of the STCW Code, since they are satisfied the remaining requirements for the issue.

3. The successful completion of the optional course unit "Advanced Health Care", meets the mandatory requirements for obtaining the certificate of "Qualification to take charge of medical care on board ships", in accordance with regulation V1/4, paragraph 2 of the STCW Code.

4. Since they are satisfied the remaining requirements for the issue, the successful completion of the optional course unit "Ship tankers" meets the mandatory requirements to obtain the following certificates:

   a) "Qualification to take charge of cargo operations on oil tankers", in accordance with paragraphs 9-14 of section A-V/1 of the STCW Code;

   b) "Qualification to take charge of cargo operations on chemical tankers", in accordance with paragraphs 16 to 21 of section A-V/1 of the STCW Code;

   c) "Qualification to take charge of cargo operations on liquefied gas tankers", in accordance with paragraphs 23 to 34 of section A-V/1 of the STCW Code.

First year

(1st semester)

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Propulsion Plants		
Field:	Thermal Installations		
Course code:	M411/3254	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Jorge Manuel Fernandes Trindade		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

This course intended that students acquire the skills necessary to analyze the mechanical and thermodynamic behavior of internal combustion engines, particularly in the case of marine compression ignition engines, and the consequences and implications of changes on the operation conditions. Some of the topics covered in the discipline of internal combustion engines of the first cycle are further detailed. Other subjects are introduced and studied here.

In Part 2 of the UC, it is intended to familiarize the student with the operation of propulsion plants with steam turbines.

Course contents:

Part I - Internal combustion engines

1. Introduction.

2. Distribution.
2.1. Composition of valve train.
2.2. Flow through valves and ports.
2.3. Design and materials of the main components of the valve train.
2.4. Analysis of forces and stresses applied on valve train components.

3. Fuel Injection.
3.1. Fuels.
3.2. Combustion.
3.3. Injection systems.
3.4. Dual-fuel engines.
3.5. Common rail injection systems.
3.6. Injection diagrams.
3.7. Consequences of the mixture composition on engine operation.
3.8. Combustion diagrams.
3.9. Ignition delay. Factors afecting the ignition delay.

4. Supercharging.
4.1. Supercharging systems.
4.2. Compressors. Turbines.
4.3. Operation diagrams.
4.4. Turbocharged two-stroke engines.
4.5. Expectation on future development.

5. Reciprocating Engines Dynamics.
5.1. Forces applied to various components.
5.2. Force diagrams.
5.3. Torque and crankshaft motion.
5.4. Forces equilibrium on two- and four-stroke engines.
5.5. Torsional vibrations.
5.6. Influence of engine motion in the hull vibration.
5.7. Prevention, isolation and vibration damping.

6. Thermal balance.
6.1. Cooling systems on marine plants.
6.2. Temperature of inside cylinder gases during the cycle.
6.3. Thermal loading and component temperatures.
6.4. Energy balance.
6.5. Heat recovery systems.
6.6. Fuel consumption optimization.

7. Pollutant Formation and Control.
7.1. Nature and extent of the problem. Regulations.
7.2. Mechanisms of formation of main pollutants.
7.3. Methods to reduce the pollutant formation.
7.4. Exhaust gas treatment.

Part II - Steam Turbine Propulsion Plants.

Exercises on steam turbines propulsion plant simulator.

Recommended reading:

Course Notes, Jorge Trindade, 2011.
J.B. Heywood. Internal Combustion Engines Fundamentals. Mc-Graw-Hill, 1988.
J. Martins. Motores de Combustão Interna, Publindústria, 2005.
D. Giacosa. Motores Endotermicos. Ed. Dossat, 1979.
K. Zinner. Supercharging of Internal Combustion Engines. Springer-Verlag, 1978.
M. Burghardt and G. Kingsley. Marine Diesels. Prentice-Hall, 1981.
ERS SP Dual Fuel Machinery & Operation, Kongsberg Maritime, 2007.

Teaching methods:

Lectures and practical exercises are comprised to achieve the course objectives. Each subject will be introduced and be followed by practical applications, when possible.

Assessment methods:

Written exams, lab reports and simulator exercises.

Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Instrumentation and Control		
Field:	Control Systems		
Course code:	M412/3255	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours / week:**	60 h / TP+PL
Name of lecturer:	Luís Filipe Baptista		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Introduce students to the basics of sensor types, transducer measurement devices, actuators and controllers commonly used in industrial and marine installations. Basic characteristics of measuring devices are described, as well as the forms of conditioning analog and digital signals and final control elements. In this unit is also provided the fundamental concepts of microprocessor-based digital control. At the end of the course, some typical examples of measuring and control applications in marine propulsion plants are also presented, as recommended by the IMO-STCW Convention.

Course contents:

1. Introduction to Instrumentation and Measures
Units of measurement. Measurement errors. Sources of error. Characterization of errors. Measurement systems. Features static, dynamic and reliability of measurement devices. Basic characteristics of the analog and digital measuring devices.

2. Signal conditioning
Modulation, filtering and linearization of analog signals. Wheatstone bridges. Differential and instrumentation amplifiers. Sources of error in operational amplifiers. Signal converters. Converter I / V, V / I, F / V and V / F.

3. Temperature transducers
Metal resistance transducers (RTD): platinum, nickel, copper. Thermistors (NTC, PTC). Thermocouples. Calibration tables. Compensation of the cold junction. Semiconductor junction transducers. Bimetallic transducer. Vapour and liquid expansion based transducers.

4. Transducers of other physical variables
Position transducers (potentiometer, capacitive, inductive - LVDT), strength and deformation (strain). Rotational transducers (tachometers) and acceleration (piezoelectric). Pressure transducers, flow rate and viscosity transducers.

5. Digital transducers
Photoconductive cells based transducers (LDR). Optoelectronic transducers. Absolute and incremental encoders.

6. Final control devices
Pneumatic / electric signal converters: I / P converter, P / I, P / V. Power amplifiers. Mechanical actuators, valves, servo valves, pneumatic and hydraulic cylinders and motors. Control valves, curves. Types of control valves: "on-off", linear, needle, equal percentage, three-way and butterfly. Examples of application of actuators in marine installations: steering gear system, variable pitch propeller (CPP) and deck machinery (winches and cranes)

7. Analog Controllers
Review of continuous control. Continuous PID controller. Practical Implementation: pneumatic and electronic controller. Static and dynamic analysis of industrial controllers. Special controllers: feedforward, cascade and ratio control. ISA schematics - PI&D. Application examples.

8. Sampled-data systems
Analog-digital conversion circuits (A / D) and digital-analog (D / A). Sample & Hold circuit. Multiplexing circuits. Sampling of signals. Sampling theorem (Shannon). Aliasing. Data acquisition

systems. Introduction to data acquisition software through the Matlab / Simulink.

9. Digital controllers

Sampled-data systems. Discrete transfer function. Difference equations. Introduction to digital control. Digital PID controller: classic and modified. Analysis and selection of the sampling period. Implementation of digital control algorithms in Matlab / Simulink. Examples of application.

10. Examples of application in marine installations

Integrated systems for monitoring, supervision and control of main and auxiliary machinery.

Recommended reading:

Lecture presentations – Luís F. Baptista, ENIDH, 2011
Controlo de Processos - Tecnologia da Instrumentação, Curtis D. Jonhson, Fundação Calouste Gulbenkian.
Instrumentación Industrial, António Creus Sole, Marcombo Boixareau.
Intelligent Instrumentation - Microprocessor Applications in Measurement and Control, George C. Barney, Prentice Hall.
Discrete-time Control Systems, Katsuhiko Ogata, Prentice-Hall Int. Editions, 1995
Computer Controlled Systems, K. Astrom, B. Wittenmark, Prentice-Hall, 1984

Teaching methods:

The teaching will be done through theoretical/practical classes and laboratory classes. The theoretical/ practical classes are used to make the presentation of concepts for each topic that previously must be studied by students. The laboratory classes will be used to apply the theoretical concepts and discussion of each topic by using the equipment in the lab.

Assessment methods:

Realization of four work groups lab exercises, with final discussion (NL). The laboratory component has a minimum grade of 10 points (scale 0 to 20). Continuous assessment consists of two written tests along the semester. The minimum score on each test is 7 points. Obtaining of a final score below 10 points, requires a mandatory final exam (NE). The final grade (NF) is the result of: NF = 0.4 *NL+0.6*NE.

Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
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Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Fracture Mechanics and Fatigue		
Field:	Applied Mechanics		
Course code:	M413/3256	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Manuel Afonso da Fonte		
Prerequisites:	Applied Mechanics; Mechanics of Materials		

Objective of the course (expected learning outcomes and competences to be acquired):

The objective of the course is to develop skills on the mathematical tools and fundamental concepts involving: design and analysis of mechanical fatigue components and structures; fatigue phenomena and design against fatigue failure; creep phenomena; linear elastic fracture mechanics (LEFM); structural stresses and fatigue component analysis using the finite element method tools.

Course contents:

1. **Introduction to the Fracture Mechanics.** Catastrophic fractures in structures, trains, ships, aircraft, pressure vessels and bridges, over the past centuries. Pictures and video shows. As Mechanics of Materials is no longer able to apply to the analysis of fracture and fatigue. Proposal for reading articles related to Fracture Mechanics and Fatigue, and case studies. Generalized Hooke's Law. Griffith's theory and fracture mechanics as a course from the 60s. Plane stress and plane strain state. Definition of ductile and brittle failure. Variation of the toughness of steels with temperature. Critical temperature of ductile-brittle transition. Experimental determination of the toughness in plane deformation state.

2. **Fatigue phenomena**
Definition of fatigue. Fatigue loading spectrums. The alternating pure spectra and other loadings. Accumulated fatigue. Curves or Wöhler S-N curves. Limit fatigue strength. Criteria of failure in fatigue. Tension fatigue limits and corrections to its value, based on the type of load, size effect, and effect of surface finish. Theoretical and practice factors of stress concentration, K_t, and its significance. Axial, biaxial and triaxial loadings. Triaxial stress state. Elastoplastic fatigue at low cycle fatigue conditions. Fatigue crack propagation (PFF). Threshold fatigue crack propagation. Fatigue surface morphologies and its characterization. Modes I, II and III of fatigue crack propagation. Stress ratio R. Effect of the mean and maximum stresses. Pair of intrinsic parameters that influence the nucleation and propagation of a crack, ΔK and K_{max}.

3. **Application of Linear Elastic Fracture Mechanics to fracture and fatigue**
Conditions to initiation and propagation of fatigue cracks. Nucleation and propagation of fatigue cracks. Fatigue crack front profiles. Formulation of the theory Westergaard-Irwin. Theory of Griffith and Irwin. Definition of stress intensity factor K and fracture toughness. Concept of fracture toughness and its importance. Critical factors K_c and a_c. Plastic deformation analysis at crack tip. Numerical and experimental methods for determining K. Graphs for obtaining the stress intensity factors K (FIT) and handbooks. Analysis of the curves da/dN vs. ΔK. Fatigue crack growth rate parameters. Selection of materials and mechanical and thermal treatments. Stress corrosion cracking (SCC) and curves da/dt. Fatigue stress corrosion cracking (FCST). Influence of the frequency of cyclic loading, stress ratio R, the thickness B, environment effect and load history. Laws of propagation of fatigue cracks. Paris-Erdogan law. Curves da/dN vs. ΔK. Integration of the Paris law for fatigue life calculation. Practical and analytical exercises.

4. **Fatigue under constant and variable amplitude loading**
Fatigue damage. Real load spectra. Accumulated damage. Calculation of cumulative damage using Miner's rule. Analysis for damage tolerance. Practical exercises. Prediction of fatigue resistance. Basic equations. Number of cycles of initiation and propagation to failure. Effect of "overloads" in the fatigue resistance. Effect of the size of plastic deformation at the crack front. Crack closure effect on fatigue crack growth rate (FCG). Residual stress effect at the crack front.

5. **Fatigue tests on rectangular and cylindrical specimens**

Fatigue testing machines. Machines for fatigue tests in rotating and reversed bending. Fatigue testing machines for rotating bending combined with steady torsion. Servo-hydraulic fatigue machines for CT, M (T) and cylindrical specimens. Ultrasonic testing machines for obtaining S-N curves. Fatigue fretting machines. Resonance fatigue machines. Fatigue testing. Fatigue machines for rotary and alternating bending. Fatigue machines of rotary bending combined with steady torsion.

6. Numerical methods applied to Linear Elastic Fracture Mechanics

Stress intensity factors K calculation. Fundamentals of finite element method for analysis in structural components with linear elastic behavior. FEM applied to the design of mechanical systems. Use of commercial software for structural and mechanical analysis. Development of practical work involving stress and strain analysis in linear elastic regime of structural components. Elastoplastic fracture mechanics. COD and fundamental concepts. Integral J. Elastoplastic testing. Analysis of structural integrity containing defects. Practical examples.

7. Ferritic steels and aluminum alloys

Carbon steels and carbon-manganese steels. High strength steels and microalloyed steels. Properties required for structural steels and aluminum alloys under fatigue. Influence of mechanical properties of on the fatigue behavior. Fatigue strength of aluminum alloys under fatigue. Checking the fatigue design of steel and aluminum alloys structures. Codes and specification design. Regulations and rules of design fatigue. Causes of fatigue crack initiation. Macro and microstructural defects. Cold cracking of steels induced by hydrogen. Cracking "fish eye". Cracking during solidification of metallic alloys.

8. Damage in composites materials subjected to impact and fatigue

Characterization of damage in composite materials. Damage and fracture mechanisms in fiber-reinforced composites: in-plane damage (fiber pull-out; fiber bridling (whiskers); fiber matrix debonding; fiber failure, matrix cracking); microbuckling, delamination and buckling delamination. Delaminating damage. Fatigue of composite materials. Repair of structural composites and quality control.

9. The fatigue behavior of welded joints

Quality control in welding. Destructive and nondestructive tests. Testing of bursting tensile and bending of welded joints. Fatigue tests on welds. Techniques to improve fatigue resistance. Residual stresses on the fatigue behavior. Effect of plastic deformation at crack front. Residual stresses influence the fatigue resistance behaviour. How to reduce the stress concentration. The importance of finishing surface of mechanical components. Introduction of compressive residual stresses for improving fatigue strength. Hammering surface, blasting (shot-penning) and overloads. Fatigue residual stresses behaviour. How can appear residual stresses. Residual stresses influence on fatigue behavior. Stress concentration reduction. Surface finishing influence. Compression residual stresses introduction. Shot-penning and pre-stress loadings. Surface protection from the environment influence. Fatigue damage assessment. The environment protection. Welding control quality. Destructive and non-destructive welding tests. Rupture testing under axial and loading bending. Rules and fatigue specification design. Probabilistic concept of collapse. Fatigue rule discussions.

10. Analysis of catastrophic failures and structural health monitoring

Techniques for monitoring the structural integrity and "state of the art" in a fracture and fatigue.
How to do an analysis of a catastrophic rupture. Characterization of the material for analysis. How to prepare the samples for obtaining the microstructure and the hardness. Observation of samples in electron microscope (SEM). Analysis and discussion of results. How to make a technical report of damage. Probabilistic models applied to fatigue. Practical exercises on calculation of fatigue life of structural and mechanical components. Introduction to Structural Health Monitoring.

Recommended reading:

- Fracture Mechanics. Fundamentals and Application, 2nd edition, 1994.
- Fatigue of Structure and Materials, Jaap Schive, 2008
- Atlas of Fatigue Curves, Howard E. Boyer.
- Fadiga de Estruturas Soldadas, C. Moura Branco, A. A. Fernandes, P. S. Tavares de Castro, Ed. Fundação Calouste Gulbenkian, 1999.
- Fadiga, Vol. I e II – Jaime de Castro e Marco António Meggiolaro (Brasil). Authors edition, 2009, in the ENIDH, Library.
- Linear Elastic Fracture Mechanics for Engineers, Theory and Applications, L.P. Pook, WIT Press, 2000.

Recommended readings:

- A Mecânica da Fractura –1ª e 2.ª parte dos artigos do Prof. Armando de Sousa Brito, IST, 2000.
- Fatigue. David Roylance. MIT, Cambridge, MA 02139, May 1, 2001.
- Structural integrity evaluation of highway riveted bridges, A.A. Fernandes, P.T. de Castro, M. Figueiredo, F. Oliveira.
- Methodologies for failure analysis: a critical survey. Paulo M. T. de Castro and A. Fernandes, Materials

and Design 25, pp. 17–123, 2004.
- Surface finish effect on fatigue behaviour of forged steel. S.A. McKelvey, A. Fatemi. International Journal of Fatigue 36, pp. 130–145, 2012

Teaching methods:

Theoretical and practical classes.

Assessment methods:

Continuous assessment:
Realization of a test (T) about the whole matter, 3 reviews (R) and a technical report of a failure by fatigue, with discussion required (RAV). Mandatory visits to laboratories, study visits and seminars. Attendance and participation (A).
Final evaluation = 0.5 T + 0.1R + 0.3 RAV +0.1 A ≥ 10 values.
Final examination:
Test on all matter (T) and delivery of mandatory reviews (3) and delivery and discussion of a technical report of a mechanical failure due to fatigue (RAV). Classes participation (A)
Final evaluation = 0.6 T + 0.1R + 0.3 RAV ≥ 10 values

Language of instruction: Portuguese / English

Escola Superior Náutica Infante D. Henrique
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Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Hydrodynamics and Propulsion		
Field:	Thermal Installations		
Course code:	M414/3257	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Jorge Manuel Fernandes Trindade		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

The aim with this course is that students acquire the skills necessary to analyze and predict the dynamic behavior of the ship at sea. The overall intended aim of the course is that students acquire the skills required in this area recommended by the IMO-STCW Convention.

Course contents:

01. Hydrodynamics.
01.01. Hull resistance. Types of resistance and their interdependence.
01.02. Frictional resistance. Pressure resistance. Wave resistance.
01.03. Dimensional analysis. Reynolds, Froude and Euler numbers.
01.04. Flow around the hull. Boundary layer.
01.05. Ship wave pattern. Gravity waves. Dispersion. Energy of wave systems. Group velocity. Ship economic speed. Influence of depth.
01.06. Prediction of the ship resistance.
01.07. Tests with scale models. Similarity laws. Ship resistance components. Ship-model correlations.

02. Propulsion.
02.01. Types of propellers.
02.02. Propellers. Geometry of the propeller.
03.02. Theory of propulsion. Momentum theory applied to a propeller. Propeller optimal efficiency.
02.04. Tests with scale models. Dimensionless coefficients. Open waters operating curves . Systematic series.
02.05. Interaction between the ship and propeller. Propulsive force coefficient. Nominal and effective wake.
02.06. Cavitation. Number of cavitation. Effects of cavitation. Erosion. Loss of propulsive force. Cavitation tests.
02.07. Propulsion tests. Compensating towing force. Determination of propulsive factors. Extrapolation to the ship scale.

03. Propulsion plants.
03.01. Comparison of the main types of propulsion plants.
03.02. Calculation of effective power and the power to install. Types of power and its calculation. Graphs of power / speed. Consumption and autonomy.
03.03. Analysis of the ship's propulsion plant represented on the simulator.

04. Complements of Naval Architecture.
04.01.Seakeeping. Maneuverability.
04.02. Trim, stability and efforts of the ship.

Recommended reading:

Course Notes, Jorge Trindade, 2010
Introduction to Naval Architecture, Eric C. Tupper, Elsevier, 2004
Basic Ship Theory, J. Rawson & E. C. Tupper, Elsevier, 2001
Arquitectura Naval, José P.F.S. Cabral, Centro de Livro Brasileiro, 1979
Practical Ship Hydrodynamics, Volker Bertram, Butterworth Heinmann, 2000

Teaching methods:	
Teaching will be made in theoretical/practical lessons.	
Assessment methods:	
Written tests and exams.	
Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	REGULATIONS AND MARITIME LAW		
Field:	Technical Management		
Course code:	M415/3258	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Ana Cristina Pimentel / João Emílio do Carmo Silva		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Understand the major academic and professional issues in Maritime Law, Conventions and Regulations and the way law and regulations impacts the commercial shipping operations; develop an awareness of the problems and risks arising from the operation of the ship; develop an understanding of how the law in general and contracts in particular can be used to deal with such problems and risks. At the end of the course students should be able to explain the fundamentals of Maritime Law, Conventions and Regulations and as they pertain to authorities, rights, duties and responsibilities in the commercial operation of sea going merchant ships. They will also be able to demonstrate knowledge and understanding of maritime laws and rules governing merchant shipping and transport activities. The course comprises the fundamentals of public law international system; maritime zones in the modern law of the sea; shipbuilding contracts; cargo claims; marine insurance; cargo insurance and international trade; transfer of risk and property; seller's duties regarding goods and documents and buyer's duty to pay; maritime causalities; collision; salvage; general average; tonnage limitation of liability; issues in arbitration and jurisdiction.

Course contents:

1 MARITIME LAW
1.1 THE SEA AND THE LAW
1.1.1 HISTORICAL EVOLUTION AND SOURCES OF MARITIME LAW
1.1.2 CHARACTERISATION, SPECIFICITIES AND INTERNATIONALISATION OF MARITIME LAW
1.1.3 MARITIME LAW AND THE LAW OF THE SEA
1.2 JURIDICAL REGIMES FOR MARITIME SPACES
1.2.1 HISTORICAL EVOLUTION FOR MARITIME SPACES
1.2.2 CONVENTIONS ON THE LAW OF THE SEA AND ITS MAIN PRINCIPLES
1.2.3 TERRITORIAL SEA
1.2.4 CONTIGUOUS ZONE
1.2.5 EXCLUSIVE ECONOMIC ZONE
1.2.6 CONTINENTAL SHELF
1.2.7 HIGH SEAS
1.2.8 OTHER AREAS OF NAVIGATION
1.3 MARITIME ADMINISTRATION
1.3.1 MARITIME AUTHORITY SYSTEM (SAM). ORGANIZATIONAL STRUCTURE AND COMPETENCES
1.3.2 NATIONAL MARITIME AUTHORITY. STRUCTURE AND COMPETENCES
1.3.3 PORT AUTHORITIES. COMPETENCES
1.3.4 MARITIME AND PORT PENALTIES
1.4 THE SHIP
1.4.1 DEFINITION, JURIDICAL NATURE AND IDENTIFICATION OF THE SHIP
1.4.2 THE NATIONALITY OF THE SHIP, REQUIREMENTS AND CONSEQUENCES
1.4.3 IMMUNITY OF STATE VESSELS
1.5 SHIP REGISTRATION
1.5.1 CONVENTIONAL REGISTRY. OWNERSHIP REGISTRY AND COMMERCIAL REGISTRY
1.5.2 TEMPORARY REGISTRATION AND PROVISIONAL REGISTRATION
1.5.3 MADEIRA INTERNATIONAL SHIP REGISTRY (MAR)
1.6 PURCHASE OF SHIPS
1.6.1 AQUISITION MODES
1.6.2 SHIPBUILDING CONTRACT
1.6.3 SALE AND PURCHASE OF SHIPS
1.7 MARITIME TRANSPORT ACTIVITY

1.7.1 THE MARITIME ADVENTURE
1.7.2 ACCESS TO THE ACTIVITY OF MARITIME TRANSPORT
1.7.3 NATIONAL CABOTAGE
1.8 MARITIME CREDITS
1.8.1 SHIPOWNER LIABILITY
1.8.2 LIMITATION OF LIABILITY OF THE SHIPWONER
1.8.3 ARREST OF SHIPS
1.8.4 MARITIME LIENS AND MORTAGES
1.9 MARITIME AVERAGE
1.9.1 SEA EVENTS
1.9.2 SEA PROTEST
1.9.3 PARTICULAR AVERAGE
1.9.4 GENERAL AVERAGE
1.9.5 AVERAGE ADJUSTMENT
1.10 MARINE POLUTION
1.10.1 THE CONVENTION ON THE LAW OF THE SEA (UNCLOS) AND THE PRESERVATION OF MARINE ENVIRONMENT
1.10.2 CRIMINAL AND ADMINISTRATIVE PROSECUTION OF OFFENDERS. INTERNAL AND INTERNATIONAL LAW
2 REGULATIONS
2.1 QUALITY, SAFETY AND ENVIRONMENT
2.1.1 ISO 9001
2.1.2 ISO 9002
2.1.3 ISO 14001
2.2 MOST RELEVANT CONVENTIONS, CODES AND REGULATIONS APPLICABLE TO THE SHIPPING
2.2.1 STCW CONVENTION
2.2.2 MARPOL CONVENTION
2.2.3 ISM CODE
2.2.4 PORT STATE CONTROL
2.2.5 ISPS CODE (INTERNATIONAL SHIP AND PORT FACILITY SECURITY CODE)
2.3 CERTIFICATION OF SHIPS
2.3.1 STATUS AND CLASSIFICATION OF SHIPS
2.3.2 PURPOSE OF SHIPS CLASSIFICATION
2.3.3 ASSIGNMENT, MAINTENANCE, SUSPENSION AND WITHDRAWAL OF CLASS
2.3.4 CLASSIFICATION NOTATIONS
2.3.5 CLASSIFICATION INSPECTIONS
2.3.6 STATUTORY CERTIFICATION OF SHIPS
2.3.7 RECOGNIZED ORGANIZATIONS
2.4 MARINE INSURANCE
2.4.1 HULL AND MACHINERY
2.4.2 ADDITIONAL COVERAGE
2.4.3 P & I CLUBS
2.5 CRISIS MANAGEMENT AND HUMAN BEHAVIOR
2.5.1 HUMAN BEHAVIOR AND RESPONSE IN EMERGENCY SITUATIONS
2.5.2 LEADERSHIP, COMMAND AND COMMUNICATIONS
2.5.3 COMMAND AND CONTROL IN EMERGENCY SITUATIONS
2.5.4 OPTIMIZATION OF RESOURCES IN EMERGENCY SITUATIONS
2.5.5 UNDERSTANDING AND IMPLEMENTATION OF EMERGENCY PLANS
2.5.6 CROWD CONTROL
2.5.7 ASSISTANCE TO PASSENGERS IN EMERGENCY SITUATIONS

Recommended reading:

Texts, articles and separate legislation (…)
BIBLIOGRAPHY:

- Armando Marques Guedes, Direito do Mar, 2ª edição, Coimbra Editora, 1998
- Azevedo Matos, Princípios de Direito Marítimo, Lisboa, 1958
- Duarte Lynce de Faria, A Jurisdição e a Delimitação dos Espaços Marítimos em Portugal
- Frederico de Lacerda, Direito Internacional e Poluição Marítima, AAFDL, Lisboa, 1988
- Jonathan Lux, "Classification Societies", Lloyd's of London Press, 1993
- José M. P. Vasconcelos Esteves, Direito Marítimo, Vol. I e III, Editora Petrony, Lisboa, 1990 e 1987
- Joaquim Sant'ana Silva, Guia Prático de Procedimento sobre Avarias Marítimas, Lisboa, 1972
- José Luis Moreira da Silva, Direito do Mar, AAFDL, Lisboa, 2003
- Luis da Costa Diogo e Rui Januário, Direito Internacional do Mar e Temas de Direito Marítimo; Direito Internacional do Mar e Temas de Direito Marítimo, Áreas Editora, Lisboa, 2000
- Manuel Januário Costa Gomes, Leis Marítimas, Almedina, Coimbra, 2007; Direito Marítimo, Vol. IV, Acontecimentos de Mar, Almedina, Coimbra, 2008
- Mário Raposo, Estudos sobre o novo Direito Marítimo, Coimbra 1999

- René Rodière, Traité Général de Droit Maritime, Dalloz, Paris, 1976
- William Tetley, «International Maritime and Admiralty Law», Editions Yvon Blais, Québec, 2002; «Maritime Liens and Claims», Second edition, Editions Yvon Blais, Québec, 1998

Z. Oya Ozçayir, «Port State Control», Lloyd's of London Press, 2001

Teaching methods:

Lectures and practical exercises are comprised to achieve the course objectives. Each subject will be introduced and be followed by practical applications, individual and group work and case studies when possible.

Assessment methods:

The continuous assessment is based on a home work and two written tests. The homework covers the matters relating to regulations it must be submitted in writing and orally discussed at a date set by the teacher responsible. The first test to be held in the middle of the semester will have as its object the matters of Maritime Law and the second test to be held at the end of the semester, covering both Maritime Law and Bylaws subjects. The final grade of 0 to 20, is the average of the results obtained by applying the following percentages: Homework-25%, 1st test-25% and 2nd test-50%. A final average below 10 values implies a final examination.

Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Naval Design Welding		
Field:	Applied Mechanics		
Course code:	M416/3266	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Manuel Afonso da Fonte		
Prerequisites:	Materials and Mechanical Technology		

Objective of the course (expected learning outcomes and competences to be acquired):

The objective of this course is to provide skills in naval ship building and repair welding and quality control as well as the adequate selection of welding processes end design.

Course contents:

1. General introduction to welding and welding technology

2. Process for welding and cutting

3. Welding materials

4. Weld ability of steels

5. Welding of aluminium alloys

6. Codes and symbols of the weld

7. Welding in shipbuilding.

8. Certification of welders and processes

9. The role of classification societies in shipbuilding

10. Production and quality control

11. Health and Safety

12. Design and calculation of welded constructions

Recommended reading:

Processos de Soldadura I e II, edição do ISQ, 1999, Biblioteca da Escola Náutica.
Metalurgia da Soldadura, edição do ISQ.
Fadiga de Estruturas Soldadas. C. Moura Branco, Ed. Fundação Calouste Gulbenkian, 1998.
Principles of Welding – Processes, Physics, Chem. and Metallurgy, Messler Jr., Wiley-VCH Verlag, 2004.
Soldadura de alumínios em construção naval. Tese de Mestrado de Natacha Martins, FCT, Dep. Ciências dos Materiais, 2008 (http://run.unl.pt/handle/10362/1929)
Principles of Metal Manufacturing Processes, J. Beddoes & M. Bibby, Elsevier, 2003.

Teaching methods:

Theoretical and practical classes.

Assessment methods:

Continuous assessment:
Realization of a written test (T) given about the whole matter, 3 chapter reviews (R) and delivery of a

technical report of naval shipbuilding welding, with discussion required (RAV). Mandatory visits to laboratories, study visits and seminars. Attendance and participation (A). Final Grade = 0.5 T + 0.1R + 0.3 RAV +0.1 A ≥ 10 values. **Final examination:** Test on all matter (T), mandatory delivery of 3 chapter reviews (R) and delivery and discussion of a technical report of naval shipbuilding welding (RAV). Final Grade = 0.6 T+ 0.1R + 0.3RAV ≥ 10 values	
Language of instruction:	Portuguese / English.

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Thermal Equipment		
Field:	Thermal Installations		
Course code:	M417/3267	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Mário Fernando Vital Melo		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

This course unit address combustion process, heat transfer, compression and pumping of fluids. Due to its important role in almost all marine installations, sizing and selection of equipment are critical to the efficiency of the ship propulsion machinery.

Course contents:

01. Combustion
01.01. Chemical kinetics.
01.02. Premix flame.
01.03. Diffusion flames.
01.04. Fuels.
01.05. Burning equipment.
01.06. Emissions.

2. Heat exchangers
2.1. Thermal and hydrodynamic analysis: coaxial tubes heat exchanger. Tube heat exchanger with cylindrical body. Plate heat exchanger. Special type heat exchanger. Cooling towers.
2.2. Evaluation and design: evaluation of features. Scaling.

3. Pumps and compressors
3.1. Turbomachinery: centrifugal pumps, centrifugal compressors.
3.2. Volumetric machines, positive displacement pumps. Displacement compressors.

Recommended reading:

Marques, A., Permutadores de calor, ENIDH, 2011
Marques, A., Turbomáquinas, ENIDH, 2011
Cooper, A., Usher, J. D. (1983), Heat Exchanger Design Handbook (Section 3.7), Hemisphere Publishing Corporation.
Fraas, A. P., Ozisik, M. N. (1965), Heat Exchanger Design, John Wiley & Sons Inc.
Guy, A. R. (1983), Heat Exchanger Design Handbook (Section 3.2), Hemisphere Publishing Corporation.
Hewitt, G. F., Shires, G. L., Bott, T. R. (1994), Process Heat Transfer, CRC Press.
Saunders, E. A. (1988), Heat Exchangers – Selection, Design and Construction, Longman Scientific & Technical.
Taborek, J. (1983), Heat Exchanger Design Handbook (Section 3.3), Hemisphere Publishing Corporation.
Tubular Exchanger Manufacturers' Association – TEMA (1988), Standard of Tubular Exchanger Manufacturers' Association, 7th ed., Tema, New York.
Cherkassky, V. M. (1977), Pumps, Fans and Compressors, Mir, Moscow.
Dixon, S. L (1981)., Mecanica de Fluidos y Termodinamica de las Turbomaquinas, Editorial Dossat, Madrid.
Khetagurov, M., Marine Auxiliary Machinery and Systems, Peace Publishers, Moscow.
Macintyre, A. J (1980)., Bombas e Instalações de Bombeamento, Guanabara Dois, Rio de Janeiro.

Teaching methods:

The teaching will be done through lectures and practical classes. It is intended that by reading the literature the student is introduced to deal with each topic. The lectures will work with brief

presentations on each topic followed by practical examples, where it is intended that the student consolidate the concepts studied. In practical classes, will carry the resolution of exercises where students apply the acquired knowledge. Some of these classes involve carrying out laboratory work, where students can check the consistency of the models studied by real events.
Assessment methods:
The assessment can be made by one of two ways: a) written test; - two laboratory assignments, b) exam; - two laboratory assignments. The final grade is obtained with minimum weighted average value of 10 (test and lab work). The weights assigned to each of the components of the evaluation are: - written test / final exam - 70% - laboratory work - 15% each.

Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Modeling and Simulation of Thermal Systems		
Field:	Thermal Installations		
Course code:	M418/3268	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Jorge Manuel Fernandes Trindade		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

The objective in this course is to provide the students with knowledge to enable them to analyze numerical simulations of processes involving fluid dynamics, with or without heat transfer. Aim is for sensitize students to the practical aspects of performing this kind of simulations and their potential usefulness.

Course contents:

1. Introduction
Examples of application of computational fluid dynamics calculations.

2. Equations that model the fluid flow
Simplifications for special cases. Incompressible flow. Steady flow.

3. Heat transfer

4. Discretization of the equations
Method of finite differences and finite volume.

5. Meshing

6. Introduction to solution methods
The algorithm SIMPLE.

7. Turbulent flows

8. Use of commercial tools / "open source codes" for modeling and simulation systems

Recommended reading:

Computational Fluid Dynamics, John D. Anderson, McGraw-Hill
Computational Methods for Fluid Dynamics, Joel H. Ferziger and M. Peric, Springer Verlag

Teaching methods:

Theoretical lessons and pratices.

Assessment methods:

The assessment may be made by one of two ways:
a) - a written test;
- Practical exercise (for a group of students);
b) - final exam;
- Individual practical exercise;

The final exam exemption is obtained with minimum weighted average of 10.

The weights assigned to each of the components of the evaluation are:
- Written test or exam - 70%;

- Practical work - 30%;	
Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Digital Systems and Microprocessors		
Field:	Control Systems		
Course code:	M419/3269	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours/week:**	60 h / TP+PL
Name of lecturer:	Victor Semedo Gonçalves		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

The aim of this course is to provide the students with the knowledge that will allow them to analyze and design digital circuits, using MSI devices as programmable logic devices, using powerful simulation tools. The course includes an introduction to microprocessor-based systems.

Course contents:

1. Technology of digital circuits
1.1. TTL and CMOS logic families
1.2. F*an-in* and *Fan-out*
1.3. Propagation delay
1.4. Merit factor
1.5. Interfacing devices of different logic families

2. Codification
2.1. Numeric and alphanumeric codes
2.2. Error-detection codes
2.3. Encoders and decoders

3. Multiplexing
3.1. Multiplexing and demultiplexing concepts
3.2. *Multiplexers*
3.3. *Demultiplexers*

4. Digital control circuits
4.1. State diagram and circuit synthesis
4.2. Circuit description and design using flowcharts

5. Programmable logic devices
5.1. PLAs, PALs, CPLDs e FPGAs
5.2. Simulation, analysis and systems design

6. Architectures of microprocessors
6.1. Internal structure of a microprocessor
6.2. Arithmetic and logic unit
6.3. General purpose registers and special function registers
6.4. *Buses* and I/O Ports
6.5. CISC and RISC structures
6.6. *Von Neumann* e *Harvard* architectures
6.7. Modified architectures

7. The 8085 microprocessor
7.1. Internal structure
7.2. *Pinout*
7.3. Instruction set
7.4. Development systems

8. Microprocessor- based systems 8.1. Peripheral access techniques 8.2. Concepts of structured programming 8.3. Structures of data acquisition and control systems
Recommended reading:
Digital Circuits and Microprocessors, H. Taub, McGraw-Hill. *8080/8085 Assembly Language Programming Manual*, Intel Corporation. *Digital Electronics Laboratory Experiments Using the Xilinx XC95108 CPLD with Xilinx Foundation*, James Stewart, Chao-Ying Wang, Pearson Education. *Contemporary Logic Design 2ED*, Randy Katz, Pearson Education. *Introductory VHDL: From Simulation to Synthesis*, Sudhakar Yalamanchili, Pearson Education Sistemas Digitais e Microprocessadores, PowerPoint presentations, V. Gonçalves
Teaching methods:
The grading of students is made of a combination of two written tests and continuous evaluation based on lab reports. The theory component grade can also be obtained in a final exam as an alternative to the 2 written tests.
Assessment methods:
Theoretical lectures and lab practice
Language of instruction: Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Advanced Health Care		
Field:	Technical Management		
Course code:	M420/3270	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	1st
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Teresa Cardoso Pinto		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Provide Marine Engineer Officers with theoretical and practical knowledge, so they can be able to deal with emergencies on board, according with IMO/STCW Convention.

Course contents:

1. TELEMEDICINE
1.1 CODU-MAR: Medical Advice Centre
1.2 Radio-medical contact - call simulation
1.3 The chain of survival
1.4 Organization of the Medical Emergency System
1.5 On board pharmacies
1.6 National and International Legislation on Health Care On board
1.7 Support Manuals

2. HUMAN ANATOMY AND PHYSIOLOGY
2.1 Cells and tissues
2.2 Blood
2.3 Cardio-circulatory System
2.4 Respiratory System
2.5 Digestive System
2.6 Urinary System
2.7 Genital System
2.8 Locomotive System
2.9 Nervous System

3. PRIMARY SURVEY
3.1 Level of conscious
3.2 **A**irway, **B**reathing, **C**irculation

4. CARDIO-PULMONARY RESUSCITATION
4.1 European algorithm of Basic Life Support
4.2 Practice of Basic Life Support - Ventilation and Chest Compressions
4.3 Airway obstruction

5. BLEEDING
5.1 Internal bleeding
5.2 External Bleeding
5.3 Techniques of bleeding control
5.4 Hypovolemic shock

6. SECONDARY SURVEY
6.1 Physical examination

7. TRAUMATOLOGIA
7.1 Trauma
7.2 Injuries: Types and treatment
7.3 Wounds: Classification and treatment
7.4 Joint injuries

7.4.1 Types and symptoms
7.4.2 Complications and treatment
7.5 Fractures
7.5.1 Classification, complication and treatment
7.6 Abdominal Trauma
7.7 Thoracic Trauma
7.8 Neurological trauma
7.8.1 Head Trauma
7.8.2 Spine Trauma
7.9 Principles of immobilization
7.10 Bandages

8. HEAT AND COLD INJURIES
8.1 Burns – types, symptoms and treatment

9. SUBMERSION ACCIDENTS
9.1 Drowning
9.2 Physiopathology, symptoms and immediate care
9.3 Diving accidents

10. TOXICOLOLOGY
10.1 Poison Classification
10.2 Contamination routes
10.3 Symptoms and treatment
10.4 Frequently poisoning
10.5 Portuguese Poison Centre
10.6 Addictions
10.7 Chemical transport

11. SEXUALLY TRANSMITED DISEASES
11.1 Hepatitis and AIDS
11.2 Treatment
11.3 Prevention

12. MEDICAL EMERGENCIES
12.1 Heart diseases – angor pectoris and myocardial infarction
12.2 Epilepsy
12.3 Diabetes: Hypoglycemia and Hyperglycemia
12.4 Anaphylaxis
12.5 Asthma
12.6 Stroke
12.7 Abdominal pain

13. NURSE CARE
13.1 Vital signs
13.2 IM injections
13.3 Oxygen administration
13.4 Dressings

14. GYNECOLOGY, PREGNANCY AND LABOUR

15. PREVENTIVE HEALTH AND DEATH ON BOARD
15.1 Vaccination
15.2 Chemical prophylaxis
15.3 Plague eradication on board
15.4 Death on board

Recommended reading:

International Medical Guide for Boats (WHO)
Emergency Medical Technician Manual

Teaching methods:

Lectures, practical simulations.

Assessment methods:	
Continuous assessment or final examination.	
Language of instruction:	Portuguese / English

First year

(2nd semester)

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Energetic Analysis of Marine Systems		
Field:	Thermal Installations		
Course code:	M421/3259	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Alfredo Manuel Nobre Marques		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Provide the student to obtain expertise in energy analysis of marine systems, including calculation of energy balances for different types of systems of the ship, which will be important in the performance analysis of their duties on board, as recommended by the IMO-STCW Convention.

Course contents:

1. Introduction to thermodynamics of energy systems.
General concepts. First law of thermodynamics. Second law of thermodynamics. Exergy. Properties of substances.

2. Steam and gas power plants.
Introduction to power cycles. Steam power plants. Facilities of internal combustion engines. Gas turbine installations.

3. Combined cycle plants.
Classification of combined cycle plants. Combined cycle plants in series. Combined cycle plants in parallel. Combined cycle plants in series / parallel.

4. Cogeneration installations / trigeneration.
Cogeneration and trigeneration. Advantages and limitations of cogeneration. Legal framework for cogeneration. The cogeneration / trigeneration in Portugal. Characteristic parameters of cogeneration. Cogeneration systems.

5. Energy management.
The energy management. Energy efficiency. Energy manager. Energy audits. Energy saving programs. Economic evaluation.

6. The energy analysis in the maritime transport.
Speed economic exploitation. Specific energy consumption. Need for electricity and heat. Energy recovery in ships. Energy savings. Energy audits on ships.

Recommended reading:

Marques, A., Análise Energética de Sistemas Marítimos, ENIDH, 2011
Haywood, R. W., Analysis of Engineering Cycles, Pergamon Press, 1991
Horlock, J. H., Combines Power Plants, Pergamon Press, 1992
Horlock, J. H., Cogeneration: combined heat and power, Pergamon Press, 1987
Çengel, Y. A., Boles, M. A., Termodinâmica, McGraw-Hill, 2001
Águas, M., Análise Energética de Sistemas, UTL, IST, DEM, 2004
Eastop, T. D., Croft, D. R., Energy efficiency, Longman Group Ltd, 1995
MAN-B&W, Energy Optimized Plants, 1995
Murphy, W. R., McKay, G., Energy Nanagement, Butterworths, 1982
O'Callaghan, P. W., Design and Management for Energy Conservation, Pergamon Press, 1981
Pita, G. P. A., Cogeração, UTL, IDT, DEM, 1995
Polimeros, G., Energy Cogeneration Handbook, Industrial Press, 1981
Roriz, L., Climatização: Concepção, Instalação e Condução de Sistemas, Edições Orion, 2007
Silva, G. M. M. V., Avaliação de Projectos, Universidade Aberta, 1997

Teaching methods:
The teaching will be done through theoretical-practical classes. Students should implement a practical work about the energy analysis of a thermal plant.
Assessment methods:
Realization of a practical work (NTP); Conducting a test during the semester or a final examination (NE); The final (NF) is the result of: NF = 0.2 × NTP +0.8 NE.

Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Systems and Electric Installations of Ships		
Field:	Control Systems		
Course code:	M422/3260	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours / week:**	60 h / TP+PL
Name of lecturer:	José Manuel Dores Costa		
Prerequisites:	Electric Circuits, Electric Machines and Drives, Electronics		

Objective of the course (expected learning outcomes and competences to be acquired):

The goal is to provide students with the technical and scientific foundations of electrical installations on board, both in low-voltage and medium voltage systems, as proposed by IMO-STCW: electrical generation systems, power conversion, and control circuits and distribution equipment are studied. Starting and control methods of motors and generators, and the load share problem between alternators running in parallel are analysed and tested in lab classes. Modern electrical propulsion systems and the associated power electronic converters are also referred.
Students should be able to understand the steady-state and transient behaviour of power generators, and transients resulting tree three-phase circuit's faults.
Standards regarding electrical installations on ships are referred.

Course contents:

1. **Three-phase electrical systems review. Per-unit (pu) values.**
   Short-circuits and overloads. Symmetrical components method. Protection systems and apparatus.

2. **Electrical sources:** Diesel-electric alternators, accumulators and fuel cells.
   Emergency power supply sources. Electric propulsion systems in ships. Power electronics converters. Harmonic distortion and EMI. Active filters.

3. **Steady-state alternator stability and transient behaviour.**
   Voltage and frequency regulators.
   Mathematical modelling and dynamic analysis. Dynamic model of a synchronous machine. Two components' method.

4. **Generators running in parallel.**
   Starting, coupling and load share control. Voltage and frequency control. Induction machines review. Doubly-fed asynchronous machine. Induction machine dynamic model. Brushless motors used in electric propulsion.

5. **Power and control switchboards and apparatus for LV and MV systems.**
   Standards for electrical installations in ships. National and international regulations: ATEX, IEC, Lloyds and Bureau Veritas.

6. **Network data communications in automation systems.**
   Communication protocols and converters for industrial networks (Profibus, Fielbus, Hart).

7. **Ships Electrical propulsion Systems.**

8. **Simulation of electrical power systems** with Matlab / Simulink and PSIM software.

Recommended reading:

Power Electronics: Converters, Applications and Design, N. Mohan, T. Undeland, W. Robbins, Wiley, 1995.
Electric Machinery, A.E. Fitzgerald, C. Kingsley Jr., S. D. Umans, MaGraw Hill, 2003.
Redes de energia eléctrica, uma análise sistémica, J. P. Sucena Paiva, IST Press, 2005.
Damir Radan, *Power Electronic Converters For Ship Propulsion Electric Motors*, Department of Marine Technology, NTNU, Norway, 2004.

Instalações Eléctricas de Embarcações, DL 379/80. Normas IEC, Lloyds, Veritas, Atex aplicáveis. Lectures notes of the course unit. Articles related with the course syllabus.
Teaching methods:
Class will consist primarily of presenting fundamental physics, maths and engineering concepts through working problems, and discussing in-class demonstrations. Key points will be highlighted by the choice of examples, which will be discussed in the context of power electrical circuit's theory. Practical lab experiences are performed to demonstrate engineering applications and results are discussed in the context of the work.
Assessment methods:
Grading is based on individual written tests (usually 2) and several lab work reports which are mandatory. The final average will be computed as follows: 60% will be from lecture tests, 40% from lab works. Each component must have a grade not inferior to 7 values. The final exam is comprehensive.
Language of instruction: Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Condition Control		
Field:	Applied Mechanics		
Course code:	M423/3261	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP+PL
Name of lecturer:	Luís Manuel Fernandes Mendonça		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

It is intended in this course provide the necessary knowledge to know when to implement the various condition control technologies most common for maintenance. Students should be able to detect faults in dynamic equipments through observation and theoretical or practical study of equipment. Is it still possible to decide which condition control approach is the most appropriate to which case, as well as knowledge of the advantages and limitations of the presented techniques.

Course contents:

1. Condition Control (CC).
Characterization and Definition of CC. Advantages and disadvantages of CC. Control parameters of the condition.

2. Conditional Maintenance Techniques.
Vibration analysis. Noise. Thermography. Ultrasound. Analysis of lubricating oils. Implementation Phases.

3. Analysis of vibration and noise.
Characterization of vibration signals. Time domain. Frequency domain. Trend curves. Standards and alarm values. Typical frequency spectra of the most common defects. Understanding noise. Characterization of beeps. Standards on noise. Examples.

4. Thermography, Ultrasonic and analysis of lubricating oils.
Fault analysis by thermography. Fault analysis using ultrasound. Fault analysis using lubricating oils. Examples.

5. New perspectives in the condition control.
Research areas of condition control and diagnosis of equipment failures. Examples.

Recommended reading:

- Collacott R., Mechanical Fault Diagnosis and Condition Monitoring. Chapman & Hall, 1982.ISBN:0-412-12930-2
- Moubray J., Reliability Centred Maintenance. Butterworth Heinemann. ISBN: 0 7506 10230 9
- Wowk V., Machinery Vibration. McGraw-Hill. ISBN: 0-07-071936-5
- Robert Wayne Ruddock, Basic Infrared Thermography Principles, ISBN-10: 0983225818, Reliabilityweb.com Press; 1st edition (December 14, 2010).
- Richard H. Lyon, Machinery noise and diagnostics, Butterworths.
- Paresh Girdhar, Cornelius Scheffer, Practical machinery vibration analysis and predictive maintenance, Elsevier.
- Teacher's notes

Teaching methods:

The teaching will be done through practical classes and laboratory classes. The practical classes will be for discussion and clarification of the concepts of each topic. The laboratory will serve for the application of theoretical concepts and discussion of each topic a series of practical examples.

Assessment methods:	
Realization of 2 lab work exercises with discussion / presentation (NL) which are mandatory. A minimal grade of laboratory values is 10. Conducting a test during the semester or a final exam (NE). The minimum score on each test is 7 values. The final (NF) is the result of: NF = 0.4×NL+0.6×NE.	
Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Refrigeration and Air Conditioning		
Field:	Thermal Installations		
Course code:	M424/3262	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours / week:**	60 h / TP
Name of lecturer:	Manuel Duarte Dias Mendes Nogueira		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Provide the student to obtain knowledge in refrigeration and air conditioning, including the calculation of thermal loads, design of facilities and components, which are important to the performance of their duties on board, as recommended by the IMO-STCW Convention.

Course contents:

1. PRODUCTION OF REFRIGERATION SYSTEMS.
Vapour compression systems. Multiple compression systems. Absorption systems.

2. DESIGN OF REFRIGERATED INSTALLATIONS.
Storage of perishable goods.
Design conditions. Cooling thermal loads. And insulation materials, properties and characteristics; vapour barrier. Design of refrigeration storage.

3. AIR CONDITIONING.
Properties of the mixtures. Thermodynamic properties applied to air conditioning. Psychometric chart. Psychometric processes.

4. CONDITIONS OF PROJECT AND THERMAL LOADS IN CLIMATE.
Analysis of meteorological data. Summer and winter design conditions.
Thermal loads in summer and winter. Thermal interior loads: people, lighting, equipment. Thermal loads of the environment: conduction, convection and radiation through walls, glazing, ceilings and floors. Infiltrations. Fresh air.

5. AIR CONDITIONING SYSTEMS.
Constant air volume. Variable air volume. Variable refrigerant systems. Water systems. Storage systems. Air handling units, fans, terminal units of air mixture. Plants of hot and cold water. High pressure systems. Energy recovery systems.
Air-conditioning systems in ships.

6. DESIGN OF AIR-CONDITIONING SYSTEMS.
Characteristic line of the room. Determination of air flow required. Heating and cooling power. Selection of equipment.
Regulations and standards. Standards and drafting stages of a project.

7. SIZING OF DUCTS AND PIPES.
Water and air flow within pipes and ducts. Losses and singular linear loads. Method of equal velocity, equal pressure drop, static recovery.

Recommended reading:

Psicrometria; Marques, Alfredo M. N.; Nogueira, Manuel D. D. M.
Le Nouveau Pohlmann, Manuel Technique du Froid; Muller, Verlag C. F., Karlsruhe; PYC Edition, France.
Fundamentals; Systems; Equipment; Applications Volumes; ASHRAE HANDBOOKS
Instalaciones Frigorificas, Rapin, P. J., PYC Edition, France.

Teaching methods:
The teaching will be done through theoretical-practical classes. There will be a laboratory practical work with a installation of air conditioning.
Assessment methods:
Realization of a practical work (NTP); Performing two tests during the semester or a final exam (NE); The final grade (NF) is the result of: NF = 0.2×NTP + 0.8×NE.

Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Ship Management		
Field:	Technical Management		
Course code:	M425/3263	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Jorge Manuel Fernandes Trindade		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

In order to acquire the competence of use of leadership and managerial skills, knowledge, understanding and proficiency are as follows:
1. Knowledge of shipboard personnel management and training;
2. Development, implementation and oversight of standard operating procedures;
3. A knowledge of international maritime conventions and recommendations, and related national legislation;
4. Ability to apply task and workload management, including:
4.1. planning and coordination;
4.2. personnel assignment;
4.3. time and resource constraints;
4.4. prioritization;
5. Knowledge and ability to apply effective resource management:
5.1. allocation, assignment, and prioritization of resources;
5.2. effective communication on board and ashore;
5.3. decisions reflect consideration of team experience;
5.4. assertiveness and leadership, including motivation;
5.5. obtaining and maintaining situation awareness
6. Knowledge and ability to apply decision-making techniques:
6.1 situation and risk assessment
6.2 identify and generate options
6.3 select course of action
6.4 evaluation of outcome effectiveness
7. Development, implementation, and oversight of standard operating procedures.

Course contents:

1. Reliability.
1.1 Failure.
1.2 Reliability concept.
1.3 Reliability evaluation.
1.4 Statistics instruments.
1.5 Systems reliability.
1.6 Maintainability.
1.7 Availability.

2. Maintenance.
2.1 Maintenance goals.
2.2 Maintenance types.
2.3 Maintenance techniques.
2.4 Economics of maintenance.
2.5 Total Produtive Maintenance.
2.6 Reliability Centered Maintenance.

3. Maintenanance management.
3.1 Organization.
3.2 Maintenance planning.
3.3 Inventory.
3.4 Planned maintenance system.
3.5 Work-Orders and schedule.

3.6 Maintenance costs.

4. Stock management.
4.1 Stock provision.
4.2 Stock costs evaluation.
4.3 Methods for stock management.
4.4 ABC analysis.

5. Shipowners, operators and managers.
5.1 Key roles in ship management.
5.2 Organizational structure of ship owners and operators.
5.3 Hierarchy of responsibility.
5.4 Hierarchy commercial.
5.5 Government entities.
5.6 Role and activities of the Technical Ship Manager.
5.7 Short, medium and long term activities.
5.8 Technical management of ships.

6. Ship registration and classification.
6.1 Flag states. Offshore records. Flags of convenience.
6.2 Role and functions of classification societies.
6.3 Ship classification.
6.4 Maintenance software and classed ship inspections.
6.5 Other inspections including on/off hire, preparation for cargo and bunker operations.

7. Maritime insurances.
7.1 Hull and machinery.
7.2 Additional coverages.
7.3 P & I clubs.

8. Quality, safety and environment.
8.1 ISO 9001, ISO 9002, ISO 14001, EMAS.
8.2 Port State Control (PSC).
8.3 ISM Code: Origin, implementation, certification, and audits.
8.4 ISPS Code.
8.5 Paris MOU.

9. Supervision of new constructions, conversions, repairs and dockings.
9.1 Preparation of the work.
9.2 Agendas.
9.3 Planning and programming.
9.4 Monitoring and control.
9.5 Reports of work and damage.

10. Bunker management.
10.1 Types of fuel supplied and characteristics.
10.2 Fuel market.
10.3 Contracts.
10.4 Measurement of quantity and quality.
10.5 Samples and tests.

11. Project Management.
11.1 Planning of project activities.
11.2 PERT and CPM techniques in planning and risk management.
11.3 Resource planning.
11.4 Execution.
11.5 Control and closing.
11.6 Use of a software tool for managing projects.

Recommended reading:

Course notes.
Organização e Gestão da Manutenção, Saraiva Cabral, Lidel, 2006.
Apoio à Decisão em Manutenção na Gestão de Activos Físicos, Rui Assis, Lidel, 2010.
Avaliação de Projectos, António Miguel, FCA, 2006.
Código ISM.
Managing Risk in Shipping - a practical guide, The Nautical Institute, 1999.

Teaching methods:
Lectures and practical exercises are comprised to achieve the course objectives. Each subject will be introduced and be followed by practical applications when possible.
Assessment methods:
Theoretical: Two tests or a final exam; Practical: Exercises and homework problems.

Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Composite Materials		
Field:	Applied Mechanics		
Course code:	M426/3271	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Victor Franco Correia		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Provide the fundamental knowledge about the composite materials and their potential compared to traditional engineering materials, and the stat-of-the-art of the current use of these materials in engineering applications.
Understand the mechanical behavior of the laminate composites and provide the tools and methodologies of design for the composite structures of general shape.
Provide the knowledge of the manufacturing processes for the fiber reinforced composite materials and their potentials for future developments and applications of those materials.

Course contents:

1. Introduction to Composite Materials.
Conventional materials in engineering: Metals; Plastics; Ceramics; Composites. Reinforcement fibres and matrix. Potentials and limitations of composite materials. State-of-the-art of applications of composite materials.
Materials for composite components: Reinforcement fibers; Matrix materials. General criteria for material selection.

2. Manufacturing processes.
Composite manufacturing techniques: production rate; cost; performance; size; shape.
Manufacturing processes for Thermoset composites: "Prepeg lay-up process"; "Wet lay-up process"; "Spray-up process"; "Filament winding process"; "Pultrusion process"; "Resin Transfer Molding process"; "Structural Reaction Injection Molding process"; "Compression Molding Process"; "Roll Wrapping process"; "Injection molding process".
Manufacturing processes for Thermoplastic composites: "Thermoplastic tape winding"; "Thermoplastic Pultrusion process"; "Compression molding"; "Hot press technique"; "Autoclave processing"; "Injection molding".
Process models.

3. Conception and design of composite components.
Ply properties. Mechanical properties of the layer. Characteristics of the reinforcement-matrix mixture. Fiber volume fraction. Fiber mass fraction. Mechanical properties of unidirectional layers. Mechanical properties of bidirectional woven fabric layers. Multidirectional layers. Properties of the metal matrix composites.
Mechanical properties of the laminate.
Sandwich structures. Bending resistance. Damage in sandwich structures.
Conception of composite components: laminate; orientation of the reinforcement fibers in each layer; laminate representation; layers sequence.
Mechanical behaviour of laminates. Membrane behaviour, bending of thin laminates, bending of thick laminates.
Examples of design of laminated composites.
Application of the finite element method to the analysis of laminated composites.
Thermomechanic and Hygrothermal effects.
Composite beams.
Laminate failure: Damage; Main failure criteria; Tsai-Hill failure criteria.

4. Joining of composite materials.
Adhesive bonding. Failure modes of adhesive bonding. Types of adhesives.
Mechanical joints using bolts and rivets. Failure modes of mechanical joints. Design parameters.

5. Applications State-of-the-art" in aerospace applications. Maritime applications. Industrial applications.
Recommended reading:
Composites Manufacturing. Materials, Product and Process Engineering, Sanjay Mazumdar, CRC Press, 2002. **Composite Materials, Design and Applications**, D. Gay, S. Hoa & S. Tsai, CRC Press, 2003 **Mechanics of Laminated Composite Plates, Theory and Analysis**, J. N. Reddy, CRC Press, 1997.
Teaching methods:
Theoretical and practical classes.
Assessment methods:
Two written exams during the semester or 1 final exam, greater or equal to 9.5.
Language of instruction: Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Tanker Ships		
Field:	Thermal Installations		
Course code:	M427/3272	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Jorge Manuel Fernandes Trindade		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Provide the students with the knowledge required to assume positions of direct responsibility in the loading and unloading of oil, chemical and liquefied gas tankers. Provide knowledge required by the STCW Convention to obtain certificates of qualification for responsibility positions in oil, chemical and liquefied gas tankers. (STCW Code, Chapter V, Regulation V / 1, paragraph 2).

Course contents:

01. National and international rules on the transport of bulk liquid cargoes
01.01 Relevant legislation, regulations, standards and conventions
01.02 Tankers security guides
01.03 Port regulations
01.04 Certification and inspection
01.05 Equipment safety certificates

02. Cargoes characteristics and properties
02.01 Hazards associated with transportation of cargo oil, chemicals and liquefied gases
02.02 Properties of liquids and mixtures
02.03 Chemical reactivity and compatibility
02.04 Polymerization
02.05 Formation and dispersion of hydrates
02.06 Formation of peroxides
02.07 Stability of saturated and unsaturated hydrocarbons and stabilization by inhibitors
02.08 Reactive cargoes for which there are no inhibitors
02.09 Meaning and interpretation of "SDS-Safety Data Sheets"

03. Oil tankers
03.01 Constructive details
03.02 Physical and chemical properties of cargoes
03.03 Loading and unloading systems
03.04 Equipment
03.04.01 Tanks, piping, valves and accessories
03.04.02 Pumps, ejectors and auxiliary equipment
03.04.03 Instrumentation

04. Chemical tankers
04.01 Constructive details
04.02 Physical and chemical properties of chemical cargoes
04.03 Loading and unloading systems
04.04 Equipment
04.04.01 Tanks, piping, valves and accessories
04.04.02 Pumps, ejectors and auxiliary equipment
04.04.03 Instrumentation

05. Liquefied gas tankers
05.01 Constructive details
05.02 Physical and chemical properties of liquefied gas cargoes
05.03 Cargo containment systems
05.04 Equipment

05.05 Systems for boil-off control
05.05.01 Compression
05.05.02 Refrigeration
05.05.02 Liquefaction and re-liquefaction
05.05.02 Diffusion and mixing

06. Health risks and personal protection
06.01 Health hazards due to dangerous atmospheres
06.02 Toxicity
06.02.01 Exposure
06.02.02 Lethal doses and concentrations
06.02.03 Exposure Limits
06.03 Low oxygen concentration
06.04 General precautions to take during confined space entry
06.04.01 Conditions for confined spaces entry
06.04.02 Suspicious unventilated compartments
06.04.03 Spaces with high or low temperatures
06.05 First aid in case of accident
06.06 Personal protective equipment

07. Safety and particular risks
07.01 Flammable atmospheres
07.02 Sources of ignition
07.03 Static electricity
07.03.01 Charge separation
07.03.02 Accumulation of charges
07.03.03 Electrostatic discharges
07.04 Processes of spontaneous ignition
07.05 Pyrophoric combustion
07.06 Hot work
07.07 Atmosphere analysis
07.07.01 Sequence of measurements
07.07.02 Types of gas analyzers
07.07.03 Measurement of oxygen concentration
07.07.04 Chemical tube indicators
07.07.05 Test and calibration of gas measuring devices
07.08 Fire Fighting

08. Inert gas systems
08.01 General principles
08.02 Control of the atmosphere of the tanks
08.03 Methods of replacing the atmosphere
08.04 Operation of inert gas systems
08.05 Equipment
08.05.01 Scrubber
08.05.02 Fans
08.05.03 Sealing devices
08.05.04 Valves and piping
08.05.05 Pressure regulating valves
08.05.06 Devices for the analysis, recording and indication of gas content
08.06 Inerting, purging and gas freeing operations
08.07 Isolation of the main inert gas line
08.08 Inert gas system operation
08.08.01 Startup procedures
08.08.02 Stop procedures
08.08.03 Safety checks
08.08.04 Inert gas system failures and actions to develop
08.09 Emergency procedures

09. Loading and unloading operations
09.01 Preparation, procedures and plans for loading and unloading
09.02 Ship / shore connection
09:03 Ship to ship operations
09.04 Cargo segregation
09.05 Loading and unloading operations
09.05.01 Oil tankers
09.05.02 Chemical tankers
09.05.03 Liquefied gas tankers
09.06 Tank cleaning
09.07 Operations with "slop tanks"

09.08 Purging and venting of cargo tanks
09.09 Ballasting and de-ballasting operations

10. Crude Oil Washing
10.01 Crude oil washing systems
10.02 COW pipe system
10.03 Washing machines
10.04 Pumping and tank draining operations
10.05 Crude oil washing systems operation

11. Pollution prevention
11.01 Equipments for the prevention of sea pollution
11.02 Oil Record Book
11.03 Actions to be taken in case of spills
11.04 Prevention of air pollution

12. Emergency procedures
12.01 Emergency plans
12.02 Alarms
12.03 Emergency procedures
12.03.01 Emergency stop of cargo operations
12.03.02 Actions to be taken in the event of essential services failure
12.03.03 Actions after collision, stranding, spillage or involvement of the ship by toxic or flammable gases

Recommended reading:

Course notes
Tanker Safety Guide, International Chamber of Shipping, 1978
International Safety Guide for Oil Tankers and Terminals, 2005
Operation of Liquid Gas Carriers, LGE Liquid Gas Equipment Ltd.

Teaching methods:

Teaching will be made in theoretical/practical lessons.

Assessment methods:

Theoretical: Two tests or a final exam;
Practical: Simulator exercises and homework problems.

Language of instruction:	Portuguese / English

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Automation and Robotics		
Field:	Control Systems		
Course code:	M428/3273	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP+PL
Name of lecturer:	Luís Manuel Fernandes Mendonça		
Prerequisites:	Automation, Instrumentation and Control		

Objective of the course (expected learning outcomes and competences to be acquired):

Additional knowledge about relevant aspects of modern control theory and use of new technologies in instrumentation and industrial automation. Education and dissemination of new concepts in the use of robotics and artificial intelligence techniques in control.

Course contents:

01. Continuous dynamic control
01.01. Transfer Functions
01.02. State models
01.03. Stability
01.04. Regulators

02. Discrete dynamical control
02.01. Z Transforms
02.02. Discrete models
02.03. Difference equations
02.04. Regulators discrete

03. Robotics
03.01. Constitution and classification of robots
03.02. Kinematics of a robot
03.03. Dynamic of a robot
03.04. Control a robot
03.05. Planning Task
03.06. Planning typical tasks

04. artificial intelligence
04.01. Fuzzy logic
04.02. Neural networks
04.03. Genetic algorithms
04.04. Optimization ACO
5.4 Techniques to control with IA

05. Marine Applications
05.01. Use of the presented methodologies
05.02. Programmable logic controllers
05.03. Applications.

Recommended reading:

Curtis D. Johnson, *Process Control Instrumentation Technology*, Prentice Hall, 2003
Nortman S. Nise, *Control Systems Engineering*, Wiley ISE, 2000
Benjamin C. Kuo. Saunders, *Digital control systems*, Second edition, college publishing electrical engineering, International edition.
John Craig, Introduction to Robotics, 1989, Addison-Wesley, 1989.
J.M.C. Sousa and U. Kaymak, *Fuzzy Decision Making in Modeling and Control*, World Scientific Pub. Co., 2002.
Katsuhiko Ogata, *Engenharia de controle moderno*. 4ª edição. Pearson, Prentice Hall.

Constantine H. Houpis and Gary B. Lamont , *Digital control systems theory, hardware, software*. McGraw Hill international editions.
L. Sciavicco, B. Siciliano, *Modeling and Control of Robot Manipulators*, McGraw-Hill, 1996.
Negnevitsky, M., Artificial *Intelligence: A Guide to Intelligent Systems*, Addison Wesley, 2002.
Notes for teachers.

Teaching methods:
Lectures and laboratory.
Assessment methods:
NF = 0.7. NT +0.3. NP NT - Average of evaluation tests NP - Average of practical laboratory (compulsory component: Presence of compulsory practical classes: 80% Minimum grade of components continuous assessment: The 8 values. The assessment by exam note requires note on the laboratory component: NF = 0.7. NEX +0.3. NP. Nex - take note of the test.

Language of instruction:	Portuguese / English

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Microprocessor Applications		
Field:	Control Systems		
Course code:	M429/3274	**Type of course:**	Optional
From:	19 September 2011		
Year of study:	1st year	**Semester:**	2nd
ECTS:	5	**Hours/week:**	60 h / TP
Name of lecturer:	Victor Semedo Gonçalves		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

The aim of this course is to enable the students to do maintenance tasks, and to develop embedded systems, emphasizing the usage of microprocessors dedicated to process monitoring and control (microcontrollers).
The first part covers essentially a brief overview of previously taught subjects and it has been included in the curriculum in order to create a common basis of knowledge and a common language among the students.

Course contents:

1. Introduction
1.1 – Microprocessors architecture
1.2 – Comparison between different microprocessors
1.3 – i8051 and PIC microcontroller families
1.4 – Peripheral access techniques
1.5 – Development tools

2. Dedicated Systems
2.1 – Systems architectures and basic techniques for working with peripherals
2.2 – Debugging Techniques
2.3 – Reading and decoding keyboards
2.4 – Working with displays
2.5 – Stepper motors control
2.6 – Analog interfaces
2.7 – DC motors control and monitoring
2.8 – Resonant transducers
2.9 – Data processing
2.10 – Interfacing with several type of transducers
2.11 – Working with I2C and SPI buses
2.12 – Communications between systems

Recommended reading:

V. Gonçalves, *Sistemas Electrónicos com Microcontroladores*, 2nd Edition, Ed. ETEP, LIDEL-FCA, ISBN 972-8480-12-1
V. Gonçalves, Sistemas Baseados em Microcontroladores PIC, Ed. Publindústria, ISBN 978972-8953-28-7

Teaching methods:

Theoretical lectures and lab practice

Assessment methods:

Two written tests or presentation of individual works

Language of instruction:	Portuguese / English

2nd year

(1st and 2nd semesters)

Escola Superior Náutica Infante D. Henrique
Departament of Marine Engineering

Master of Engineering in Marine Engineering			
Description of individual course unit			
Course title:	Dissertation/Project/Report		
Field:	Applied Mechanics / Thermal Installations / Control Systems / Technical Management		
Course code:	M511/3275	**Type of course:**	Mandatory
From:	19 September 2011		
Year of study:	2nd	**Semester:**	Annual
ECTS:	60	**Hours/week:**	60 h / OT
Name of lecturer:	Manuel Duarte Dias Mendes Nogueira		
Prerequisites:			

Objective of the course (expected learning outcomes and competences to be acquired):

Course unit aimed at the study and analysis of a topic to be discussed in the form of thesis, project or internship report during the second year of studies.

Course contents:

Course unit that corresponds to the work done by the student for the thesis, project or internship report referred to in the syllabus. The work should demonstrate the skills acquired by the student in reports, although with a higher depth level resulting from the learning process. The work should deal with multidisciplinary subjects. The final document must be subject to public discussion with a jury.

The work must deal with a topic taught in Applied Mechanics, Thermal Installations, Control Systems or Technical Management course units. The final work should emphasize the skills acquired by students in the field of Marine Engineering.

Recommended reading:

Specifically related with the studied topic.

Teaching methods:

Tutorial support.

Assessment methods:

Public discussion.

Language of instruction:	Portuguese / English