NATIONAL TECHNICAL UNIVERSITY OF ATHENS

School of Naval Architecture and Marine Engineering

Course Guide

December 2015

1 COURSE PROGRAMME

1.1 Mandatory Courses of the 1st Semester

Code	Course	School - Division	Hours/ Week	Credits
8.1.01.1	Introduction to Naval Architecture	SNAME-SDMT	2	2
8.3.03.1	Mechanical Drawing	SNAME-ME	5	5
8.4.24.1	Introduction to Manufacturing Technology and Laboratory	SNAME-MS	2	2
3.3.69.1	Programming with MatLab	SECE-DCEIE	3	3
9.2.03.1	Linear Algebra and Analytic Geometry	SAMPS-Mathematics	4	4
9.2.12.1	Mathematical Analysis I (Functions of a Single Variable)	SAMPS-Mathematics	4	4
9.3.01.1	Mechanics of Solid Bodies	SAMPS-Mechanics	4	4
9.4.81.1	Physics I (Mechanics)	SAMPS-Physics	4	4
	One course from group A1	SAMPS- DHSSL	2	2
	Number of courses: 9	Total Hours/Week:	30	30

1.2 Mandatory Courses of the 2nd Semester

Code	Course	School-Department	Hours/Week	Credits
8.9.01.2	Computer Aided Mechanical Drawing	SNAME-SME and SDMT	4	4.5
8.1.02.2	Ship Drawings	SNAME-SDMT	2	2.5
3.3.70.2	Fortran and Object Oriented Programming	SNAME-ME	4	4
9.2.18.2	Mathematical Analysis II (Functions of Several Variables. Vector Analysis)	SAMPS-Mathematics	6	5.5
2.1.01.2	Engineering Economics	SAMPS-Mathematics	4	4
9.3.02.2	Mechanics of Deformable Solids I & Laboratory	SAMPS-Mechanics	6	5.5
9.4.82.2	Physics II (Electromagnetism)	SAMPS-Physics	4	4
Number of Courses: 7		Total Hours/Week:	30	30

1.3 Mandatory Courses of the 3rd Semester

Code	Course	School-Department	Hours/Week	Credits
8.2.01.3	Hydrostatics and Ship Stability I	SNAME-SMH	4	4
8.4.21.3	Material Science and Technology I and Laboratory (Metallic Materials)	SNAME-MS	4	4.5
8.3.81.3	Electrical Technology	SNAME-ME	4	4
9.2.24.3	Ordinary Differential Equations	SAMPS-Mathematics	2	2.5
9.2.25.3	Complex Functions	SAMPS-Mathematics	3	3
9.2.48.3	Numerical Analysis and Laboratory	SAMPS-Mathematics and SNAME-SDMT	6	5.5
9.3.03.3	Mechanics of Deformable Solids II	SAMPS-Mechanics	4	4
9.4.85.3	Experimental Physics	SAMPS-Physics	2	2.5
Number of courses: 8		Total Hours/Week:	29	30

1.4 Mandatory Courses of the 4th Semester

Code	Course	School-Department	Hours/Week	Credits
8.2.05.4	Mechanics of Fluids	SNAME-SMH	4	4.5
2.2.01.4	Thermodynamics I (Single Variable Thermodynamics)	SME-Thermal Engineering	6	5.5
8.3.80.4	Electro-technical Applications and Electrical Laboratory for Naval Architects and Marine Engineers	SNAME-ME	4	4
8.3.05.4	Machine Elements (Strength of Machine Elements, Transmission, Gearing)	NAME-ME	6	5.5
8.4.22.4	Materials Science and Technology II & Laboratory (Non-metallic materials, Corrosion)	SNAME-MS	4	4.5
9.2.29.4	Dynamics of Solid Bodies	SAMPS-Mechanics	4	4.5
	Foreign Language		2	2
	Number of courses: 7	Total Hours/Week:	30	30.5

1.5 Mandatory Courses of the 5th Semester

Code	Course	School-Department	Hours/Week	Credits
8.2.20.5	Basic Principles of Ship and Marine Hydrodynamics	SNAME-SMH	4	4
8.2.11.5	Ship Resistance and Propulsion	NAME-SMH	4	4.5
8.4.10.5	Ship Strength	SNAME-M S	6	5.5
9.2.29.5	Partial Differential Equations and Boundary Value Problems	SAMPS-Mathematics	5	4.5
9.2.70.5	Probability Theory and Statistics. Applications in the Marine Environment and Laboratory	SAMPS-Mathematics and SNAME-SMH	6	5.5
8.3.01.5	Introduction to Automatic Control Systems	SNAME-ME	4	3
Number of courses: 7		Total Hours/Week	32	4
				31

1.6 Mandatory Courses of the 6th Semester

Code	Course	School-Department	Hours/Week	Credits
8.1.30.6	CAD/CAM Systems for Ship Design and Construction	SNAME-SDMT	4	4
8.2.02.6	Hydrostatics and Ship Stability II	SNAME-SMH	2	2.5
8.2.12.6	Ship Dynamics and Laboratory	SNAME-SMH	4	4
8.4.11.6	Ship Structures (Local strength problems)	SNAME-MS	6	5.5
8.4.38.6	Dynamics of Marine Structures	SNAME-MS	4	4
2.2.03.6	Heat Transfer I (General Principles and Applications)	SME- Thermal Engineering	6	5.5
2.2.04.6	Internal Combustion Engines I and Laboratory	SME- Thermal Engineering	6	5.5
	Number of courses: 7	Total Hours/Week	32	31

1.7 Mandatory Courses of the 7th Semester

Code	Course	School-Department	Hours/Week	Credits
8.1.10.7	Ship Design and Outfitting I (Methodology of Ship Preliminary Study)	SNAME-SDMT	6	5.5
8.1.15.7	Ship Design Project I	SNAME-SDMT	4	2
8.1.20.7	Economics of Maritime Transport I	SNAME-SDMT	4	4
8.3.10.7	Ship Systems and Marine Auxiliary Machinery (Networks, Hydraulic Systems, Deck Machinery)	SNAME/ME	6	5.5
8.3.12.7	Marine Propulsion Plants	SNAME/ME	4	4
8.3.39.7	Dynamics and Vibrations of Machinery and Shafting Systems of Ships	SNAME/ME	4	4
8.4.20.7	Shipbuilding Technology and Laboratory	SNAME/MS	5	5
	Number of courses: 7	Total Hours/	33	30

1.8 Courses of the 8th Semester

A) Mandatory Courses

Code	Course	School-Department	Hours/Week	Credits
8.1.11.8	Ship Design Project I	SNAME-SDMT	4	10
8.1.11.8	Ship Design and Outfitting II (Detailed Ship Study and Design)	SNAME-SDMT	6	5.5
8.1.21.8	Economics of Maritime Transport II	SNAME-SDMT	4	4
8.3.20.8	Energy Systems of Ships	SNAME-ME.	5	5

B) Elective Courses -Thematic Units

Thematic Unit A: Marine Environment and Interaction with Ships and Floating Structures

Code	Course	School-Department	Hours/Week	Credits
8.4.35.8	Design of Floating Structures	SNAME-MS	5	5
8.1.42.8	Course Stability and Maneuverability	SNAME-SDMT	4	4
8.2.27.8*	Computational Hydrodynamics and Laboratory	SNAME-SMH	4	4
8.2.37.8	Stochastic Modeling and Marine Systems Prediction	SNAME-SMH	4	4
8.2.14.8	Ship Behavior in Undulations and Applications	SNAME-SMH	4	4

* It will not be given in the academic year 2015-2016

Thematic Unit B: Study, Design and Construction of Ships and Floating Structures

Code	Course	School-Department	Hours/Week	Credits
8.1.16.8	Ship Design	SNAME-SDMT	4	6
8.4.23.8	Structural Analysis and Design of Composite Materials Vessels	SNAME-MS	5	5
8.4.25.8	Science and Technique of Welding	SNAME-MS	4	4
8.4.27.8	Health and Safety in the Shipbuilding Industry	SNAME-MS	3	3
8.1.13.8	Ship Design for Safety and Environmental Protection	SNAME-SDMT	3	3
8.1.36.8	Virtual Reality and Applications to Ship Design	SNAME-SDMT	4	4

Thematic Unit C: Marine Engineering and Ship Propulsion

Code	Course	School-Department	Hours/Week	Credits
8.3.15.8	Marine Diesel Engines	SNAME/ME	4	4
8.3.61.8	Marine Engineering Laboratory I	SNAME/ME	4	4
8.2.13.8	Hydrodynamics of Modern Ship Propulsion Systems	SNAME/SMH	4	4
8.3.45.8	Ship Control Systems	SNAME/ME	4	4
8.2.40.8	Measurements in Marine Environment	SNAME/SMH	4	4

Thematic Unit D: Ship Operation and Sea Transport Systems Management

Code	Course	School-Department	Hours/Week	Credits
8.1.26.8*	Elements of Finance - Special Topics in Ship Finance	SNAME-SDMT	4	4
8.3.56.8	Sensor Technology - Diagnostics and Prognostics of Machinery Failure	SNAME-ME	4	4
8.1.28.8	Ports And Intermodal Transport	SNAME-SDMT	3	3
8.2.41.8	Artificial and Computational Intelligence in Ship Design and Operation	SNAME-SMH	4	4
8.1.24.8	Risk Theory, Engineering and Applications in Maritime Transport	SNAME-SDMT	4	4

*It will not be given in the academic year 2015-2016

Students must complete successfully the three mandatory courses of the 8th semester.

The ten (10) in total elective courses of the 8th and 9th semester are selected from the thematic units and the course groups A, B and C, with a free choice of the number of courses of each semester. From the ten (10) elective courses of the 8th and 9th semester, students must select at least two (2) courses from each thematic unit.

1.9 Courses of the 9th Semester

A) Elective Courses -Thematic Units

Thematic Unit A: Marine Environment and Interaction with Ships and Floating Structures

Code	Course	School-Department	Hours/Week	Credits
8.4.36.9	Mooring Systems of Floating Structures	SNAME -MS	4	4
8.2.15.9	Hydrodynamic Design of Small Vessels	SNAME -SMH	4	4
8.1.41.9	Roll Stability and Regulations Background	SNAME-SDMT	4	4
8.2.29.9	Wave Phenomena in the Sea Environment	SNAME -SMH	4	4
8.2.25.9	Mathematical modelling of lifting flows	SNAME -SMH	4	4

Thematic Unit B: Study, Design and Construction of Ships and Floating Structures

Code	Course	School-Department	Hours/Week	Credits
8.1.35.9	Computer-Aided Ship Design	SNAME-SDMT	4	4
8.4.17.9	Vibrations of Hull and Elements of Ship Construction	SNAME-MS	4	4
8.4.40.9	Computational Methods and Applications in Marine Construction	SNAME-MS	4	4
8.4.12.9	Analysis of Metal Constructions in Marine Structures in the Elastoplastic Region	SNAME-MS	4	4

Thematic Unit C: Marine Engineering and Ship Propulsion

Code	Course	School-Department	Hours/Week	Credits
8.3.60.9	Marine Engineering Laboratory II	SNAME-ME	4	4
8.3.35.9	Noise and Vibration Technology in Naval Architecture And Marine Engineering	SNAME-ME	4	4
8.3.21.9	Combustion	SNAME-ME	4	4

Thematic Unit D: Ship Operations and Sea Transport Systems Management

Code	Course	School-Department	Hours/Week	Credits
8.3.55.9	Ship and Fleet Operation and Maintenance	SNAME-ME	4	4
8.4.50.9	Supervision- Maintenance and Repair of Ship Metal Structures	SNAME -MS	4	4
8.1.27.9*	Maritime Transport Logistics	SNAME - SDMT	4	4
8.1.29.9	Economics of Maritime Transport III: Environmental and Safety Analysis	SNAME - SDMT	3	3
8.1.23.9	The Human Element – Introduction to Human Reliability for Maritime Transport	SNAME - SDMT	4	4

*It will not be given in the academic year 2015-2016

The ten (10) in total elective courses of the 8th and 9th semester are selected from the thematic units and the course groups A, B and C, with a free choice of the number of courses of each semester. From the ten (10) elective courses of the 8th and 9th semester, students must select at least two (2) courses from each thematic unit.

1.10 Elective Courses: Pedagogic Courses and Foreign Languages

Group A

	Course	Sem.	Hours/Week	Credits
A.1				
	SAMPS - DHSSL			
1.	Sociology of Science, Technology and Civilization (9.1.21.1)	1	2	2
2.	Political Economy (9.1.31.1)	1	2	2
3.	Introduction to Philosophy (9.1.41.1)	1	2	2
4.	History of Science and Technology (9.1.56.1)	1	2	2
A.2				
	SAMPS - DHSSL			
5.	Greek and International Mercantile Marine (9.1.35.8)	8	2	2
6.	Special Topics in Industrial Sociology (9.1.24.8)	8	2	2
7.	History of Economic Theories (9.1.34.8)	8	2	2
8.	Theory of Knowledge in Modern and Contemporary Philosophy (9.1.46.8)	8	2	2
9.	Introduction to Philosophy of Science (9.1.47.8)	8	2	2
10.	Introduction to the History of Engineering (9.1.57.8)	8	2	2
	SAMPS - Mathematics			
11.	Numerical Analysis II (9.2.52.8)	8	3	3
12.	Advanced Topics in Partial Differential Equations – Integral Equations (9.2.35.8)	8	3	3
	SAMPS - Mechanics			
13.	Elasticity Theory (9.3.07.8)	8	3	3
14.	Disks - Plates - Shells (9.3.09.8)	8	3	3

Courses from Schools other than Mechanical Engineering (SME)

	Course	Sem.	Hours/Week	Credits
15.	General Chemistry (5.1.30.8) - SChE	8	4	4
16.	Information Processing (3.2.42.8) - SECE	8	2	2
17.	Electronics (3.3.43.8) – SECE	8	3	3

A.3

SAMPS - DHSSL

18.	Elements of Law and Maritime Law (9.1.11.9)	9	4	4

SAMPS - Mechanics

19.	Fracture Mechanics (9.3.06.9)	9	3	3
20.	Numerical Methods in Engineering I (9.3.08.9)	9	2	2
21.	Analytical Mechanics (9.3.10.9)	9	3	3

SAMPS - Physics

22.	Physics III (Wave Mechanics) (9.4.84.9)	9	3	3

Courses from Schools other than Mechanical Engineering (SME)

23.	Corrosion of Materials and Selection Criteria for Naval Architecture and Mechanical Engineering Applications (5.3.23.9) – SchE	9	3	3
24.	Fuel & Lubrication Technology (5.4.08.9) - SChE	9	3	3

GROUP B

School of Mechanical Engineering (SME)

	Course	Sem.	Hours/Week	Credits
1.	Hydrodynamic Machines I and Laboratory (2.5.04.8)	8	5	5
2.	Operational Research I (2.1.07.8)	8	4	3.5
3.	Production Planning and Control I (2.1.12.8)	8	4	4
4.	Refrigeration I and Laboratory (2.2.11.8)	8	4	4.5
5.	Elements of Machines II (2.3.05.8)	8	6	5.5
6.	Operations Research Laboratory (2.1.14.9)	8	4	4
7.	Elements of Machines I (2.3.04.9)	9	6	5.5
8.	Production Planning and Business Management (2.1.02.9)	9	5	4.5
9.	Steam Generators I and Laboratory (2.2.07.9)	9	6	5.5
10.	Heat Transfer II (2.2.08.9)	9	4	4
11.	Turbomachines (2.5.06.9)	9	4	4
12.	Production Planning and Control II (2.1.16.9)	9	4	4
13.	Industrial Fluid Mechanics (2.5.05.9)	9	4	4
14.	Air Conditioning and Laboratory (2.2.17.9)	9	4	4

GROUP C

School of Naval Architecture and Marine Engineering (SNAME)

	Course	Sem.	Hours/Week	Credits
1.	Applied Functional Analysis with applications in engineering problems (8.2.36.8)[1]	8	3	3
2.	Environment and Growth (0.9.01.8)	8	3	3
3.	Introduction to Nonlinear Systems and Applications in Naval Architecture (8.9.03.9)	8	4	4
4.	Practical Training (8.9.45.8)	8 & 9	4	12
5.	Wavelets. Time-frequency domain analysis and applications (8.2.38.9)[2]	9	4	4
6.	Ship Design Project I,II,III,IV (8.9.91.9)[3]	8 & 9	12	12

[1] As of the academic year 2004-2005, the course is offered every second academic year

[2] As of the academic year 2005-2006, the course is offered every second academic year

[3] Only students who have not completed successfully will enroll

1.11 1st Semester Courses

8.1.01.1 Introduction to Naval Architecture and Marine Technology (Mandatory,1st Semester)

Introduction to naval architecture. Nomenclature and ship types. Introduction to the scientific fields of naval architecture and marine engineering (design, hydrodynamics, structures, marine engineering, ship building technology) and economics of maritime transport. Elements of marine technology, activities in the marine environment.

G. Zarafonitis

8.3.03.1 Mechanical Engineering Draughting (Mandatory,1st Semester)

Introduction to technical draughting. Types of draughting. International standards and practice. Paper sizes. Scales. Types and use of line styles. Annotation tables. First and third angle projection. Construction and layout of multiview drawings. Auxiliary views. Types of section views. Drawing conventions. Dimensioning and tolerancing practice. Fit types. Surface quality. Threads and threaded fasteners. Draughting of mechanical assemblies.

C. Papadopoulos

8.4.24.1 Introduction to Manufacturing Technology and Laboratory (Mandatory, 1st Semester)

Introduction to Manufacturing Processes. Measuring Technology (Metrology). Surface Integrity. Bulk Deformation Processes. Sheet-Metalworking Processes. Conventional and Non-Conventional Material-Removing Processes. Cutting Tools. Machines Tools Principles. Cutting and Forming Machines Tools. Numerically Controlled Machine Tools. Computer Assisted Automation. Metal Casting. Welding Processes. Powder Metallurgy.

Two laboratory exercises (including submission of technical reports) entitled:

a) “Measuring techniques”

b) “Material machining using conventional machines tools”

D. Pantelis

3.3.69.1 Programming with MATLAB (Mandatory, 1st Semester)

Introduction. Giving values to variables, basic operations and functions.

Conditions and iterative loops. Creating column, line and multidimensional matrices. Transactions between matrices, determinant of a matrix. Inverse matrix. Solving linear systems.

Creating the desired functions by the user. Create and display curves in R2 and R3. Turn and parallel curve shift. Tangent vectors and tangent unit vector along a curve. Curvature.

Functional numerical integration. Area calculation for closed shapes in R2. Calculating curve length. Functional maxima and minima. Solving polynomial equations.

Basics of symbolic calculations in MATLAB (symbolic MATLAB). Calculation of eigenvalue and eigenvector matrices. Symbolic differentiation and integration.

Introduction to surfaces in R3 and display in MATLAB. Vector perpendicular to surface and tangent plane.

K.Papaodyssefs

9.2.03.1 Linear Algebra and Analytic Geometry (Mandatory, 1st Semester)

Vector calculus (interior, exterior and triple vector dot products). Straight - Level - sphere - cylindrical surfaces. Matrices, determinants and linear systems. Vector and affine spaces. Linear maps - Change base. Eigenvalues and eigenvectors. Applications (e.g. to solve the linear system of differential equations of the form and / or in finding resonance frequencies oscillator system). Additionally, applications in discrete dynamic systems. Inner product - orthogonality. Quadratic forms. Positively defined tables. Square form applications for second degree curves and surfaces.

P.Psarakos

9.2.12.1 Mathematical Analysis (One Variable Functions) (Mandatory, 1st Semester)

The real number field. Elements of logic. Introduction to set theory. Sequences and series of real numbers. Real functions of a single variable. Differential calculus of functions of a single variable. Indefinite and definite integrals. Applications. Power Series. Generalized integrals. Convergence criteria. Gamma and Beta functions. Ordinary differential equations of the first order (graphical solution, separation of variables, homogeneous, linear, Bernoulli). Linear second order equations with constant coefficients. Applications.

A.Arvanitakis

9.3.01.1 Mechanics of Solid Bodies
(Mandatory, 1st Semester)

Statics of points: Forces at: vectors, resultant vectors, vector analysis, point equilibrium. Forces on site: Cartesian coordinates of forces, sum of forces, equilibrium of a point in space.
Solids - Equivalent force systems: Internal and external forces, sliding vectors, cross product, moment of force with respect to a point, inner product, mixed product, moment of force about an axis, force couple, reduction of system of forces, equivalent force systems, central axis.

Static equilibrium of rigid bodies: free-body diagram. Level equilibrium: reaction support and connections, plane rigid body equilibrium, static indeterminacy. Space equilibrium: rigid body three-dimensional equilibrium, support reaction and connections.
Distributed forces – centers of gravity: Surfaces and lines: two-dimensional center of gravity of flat surface and line, static moment of a plane surface and line, Pappus-Guldinus theorems, distributed forces (loads) beams. Volumes: center of gravity in three dimensions.
Construction Analysis. Trusses: plane simple trusses, node method, spatial trusses, the Ritter method of sections, composite trusses.
Frames: Complex structures. Mechanisms.
Beams: Internal forces, axial force, shear force, bending moment, relations between load, axial, shear and bending moments, axial diagrams, cutting and bending moment diagrams.
Cables: Cables with concentrated loads, cables with distributed loads.
Friction: Slide friction, rolling friction, screws, wedges, straps.
Principle of virtual work: Potential Energy: Power Project, the priniple of virtual work, applications. Dynamic weight energy, dynamic spring energy, potential energy and equilibrium, applications, equilibrium stability.

Ch.Giounis

9.4.81.1 Physics I (Mechanics)
(Mandatory, 1st Semester)

Vector formulation of physical laws. Newton's laws. Gravitational, electrical and magnetic forces. Motion in one and three dimensions. Co-ordinate systems. Conservation of momentum. Impact. Variable mass systems. Work. Kinetic energy. Conservative forces. Dynamic energy. Conservation of energy. Motion of body systems. Moment of a force. Angular momentum. Moment of inertia. Conservation of angular momentum. Elements of dynamics of a solid body. Inverse square law forces. Vibrations. Harmonic oscillator. Harmonic oscillator with damping. Forced vibrations, resonance.

M. Kokkoris

1.12 2nd Semester Courses

8.9.04.2 Computer Aided Mechanical Engineering Draughting (Mandatory, 2nd Semester)

Historical evolution of computer aided design and draughting. Geometric kernel. Representation of geometric entities. Affine transformations. Parametric design. Feature based design. Geometric and dimensioning constraints. Projection types. Introduction to Autodesk Inventor. Generation of sketches. Generation of solids. Application to the design of Shafts, Keys, Threaded fasteners, Gears, Bearings. Generation of mechanical assemblies. Limits, fits, tolerances, surface quality: CAD Application. Libraries of standard machine elements. Disassembly of mechanical systems. Automated construction of 2-D drawings.

A. Gkinis, C. Papadopoulos

8.1.02.2 Ship Draughting (Mandatory, 2nd Semester)

Basic types of ship drawings: lines drawing, hydrostatic curves, floodable lengths drawing, Bonjean curves, general arrangement drawing, construction drawings, propeller drawings, rudder drawings, etc. Computer aided design of hull surface. From traditional lines drawings to computer-based, three-dimensional grids, surfaces and solid bodies. Considerations from Ship Hydrostatics, Hydrodynamics, Resistance and Design on the development of Ship Drawings.

G. Zarafonitis, A. Gkinis

3.3.70.2 FORTRAN & Object Oriented Programming (Mandatory, 2nd Semester)

Introduction to programming language FORTRAN. Simple data types, constants and variables, expressions, simple commands. Control structures, functions and procedures, parameter passing. Identification of proper planning methodology: algorithms, data structures, repetition, recursion, structured programming. Software development phases: requirements, design, implementation, verification, documentation, program maintenance. Advanced data structures: lists, records, linked lists. Dynamic memory allocation. Basic object-oriented programming concepts: abstract data types, classes, objects, variables, methods, encapsulation, inheritance, polymorphism. Connecting with other FORTRAN programming languages. Laboratory: Implementation examples and solving problems with programming language FORTRAN. Application interface techniques with C/C ++.

G. Papalambrou

9.2.18.2 Mathematical Analysis II (Functions of Several Real Variables. Vector Analysis)
(Mandatory, 2nd Semester)

The Euclidean space Rn. Topology of a metric space. Co-ordinate systems: polar, cylindrical and spherical co-ordinates. Limit and continuity of functions of several variables. Basic theorems. Differential calculus of functions of several variables. The implicit and inverse function theorems. Extrema of functions of several functions and problems with constraints. Conditional extrema. Elements of differential geometry. Curvilinear co-ordinates. Integral calculus of functions of several variables. Double and triple integrals and their applications. Line and surface integrals. Applications. The theorems of Green, Gauss and Stokes. Vector analysis: the divergence and rotation of a vector field, integral formulas, special types of vector fields. Continuum mechanics applications.

A. Arvanitakis

2.1.01.6 Engineering Economics
(Mandatory, 2nd Semester)

Business objectives and managerial decision making. Industry competitiveness and strategies for improvement: product development, pricing and sales promotion. Cost analysis, determinants of unit cost and comparison of engineering alternatives. Productivity: issues of definition, measurement and interpretation; prevailing approaches. Functional relationships between productivity and managerial control ratios. Use of productivity models for evaluation and planning purposes. Case studies and applications from real data pertaining to individual companies and sectors of Greek industry.

K. Aravosis

9.3.02.2 Mechanics of Deformable Solids I & Laboratory
(Mandatory, 2nd Semester)

Right stress and strain. Mechanical properties of materials. Elasticity, plasticity and creep. Linear elasticity, Hooke law, Poisson distribution. Shear stress and distortion. Design for axial loads and direct shear.
Axially loaded bars. Hyperstatic constructions. Effect of temperature, defects and prestressing. Stresses on inclined sections. Strain energy due to axial load and shear. Impact stressing. Repeated loading and fatigue. Stress concentration. Nonlinear behavior. Elastoplastic analysis.
Plane stress. Relationship between elastic modulus and shear modulus. Main stresses and maximum shear stresses. Mohr circle. Hooke Law for flat stress. Triaxial stress state. Flat

strain. Spherical and cylindrical thin-walled pressure vessels. Failure criteria Mises, Tresca, Coulomb.
Moments of inertia of plane sections. Theorem of parallel axes. Polar moment of inertia. Product of inertia. Axis torsion. Principal moments of inertia.
Torsion of circular shafts of linear elastic materials. Stresses and strains in pure shear. Non-uniform torsion. Strain energy due to torsion. Power transfer from rotating shafts. Hyperstatic axes under torsion.
Pure bending. Curvature of beams. Longitudinal right strains and stresses. Design of beams with respect to right stresses. Non-prismatic beams. Bending of axially loaded beams. Strain energy due to bending.

Laboratory: tension, compression, torsion, bending, hardness measurements, buckling.

D. Eftaksiopoulos
Laboratory: Kolovos

9.4.82.2 Physics II (Electromagnetism) (Mandatory, 2nd Semester)

Electric charge. Coulomb's Law. Electrostatic field. Gauss' theorem. Electric potential. Poisson and Laplace equations. Electrostatic energy. Conductors. Dielectrics. Polarisation. Capacity, capacitors. Moving loads, electric current, Ohm's law. Fields of translating electric loads. Magnetic fields. Lorentz force. Ampère and Biot-Savart laws. Induction. Faraday's law. Alternating current circuits. Translation current and Maxwell's equations. Electromagnetic waves.

M. Kokkoris

1.13 3rd Semester Courses

8.2.01.3 Ship Hydrostatics and Stability I (Mandatory, 3rd Semester)

Geometry of ships. Drawing of ships lines. Geometric properties of arbitrary shapes. Geometry of the hull. Hydrostatic curves. Intact stability. Generalized hydrostatics of small variations. Initial stability. Stability at large angles. Righting arm. Free surfaces. Dynamic stability. Cross curves of stability. Trim diagrams. Regulations. Stability of grounded ship. Calculation of drafts and displacement at trimmed conditions. Effect of imposed weights on the stability, the general problem. Inclining experiment. Laboratory: Calculations of Hydrostatic Diagram, Cross Curves and Floodable Length for an analytically described ship. Demonstration of ship stability in the NTUA Towing Tank.

K. Belibasakis

8.4.21.3 Materials Science and Technology I and Laboratory (Metallic Materials) (Mandatory, 3rd Semester)

Crystalline Structure of Metals. Crystal Defects. Physical and Mechanical Properties. Mechanical Tests. Equilibrium Phase Diagrams. Fe-C Binary System Study. Solid State Structural Transformations. Hardening Methods. Heat Treatments. Surface Treatments. Industrial Alloys (steels, cast irons, aluminum alloys, titanium alloys, copper alloys).

One laboratory exercise (including submission of a technical report) entitled:

"Thermal Treatments of Marine and Construction Steels".

D. Pantelis

8.3.81.3 Electrical Technology (Mandatory, 3rd Semester)

Signals and systems, electric circuits and networks, electric circuit analysis, Sinusoidal Steady State Analysis, Electric power and energy, Three-phase networks, Electric Network analysis via Laplace transform, Electric Network analysis via computer programs, interference of electric current with the human body and tissues, magnetic circuits.

At the laboratory sessions, the students get acquainted with electric instrumentation and they deal with symmetrical and unbalanced three-phase circuits in sinusoidal steady-state.

J. Prousalidis

9.2.24.3 Ordinary Differential Equations
(Mandatory, 3rd Semester)

Sequences and series of functions. Exact differential equation. Second order and higher order differential equations. Series solutions. Legendre equation. Bessel equation. Systems of differential equations. General solution of a system with constant coefficients. Laplace (Fourier) transformations. Inversion theorems. Application to the solution of differential equations and systems of differential equations. Stability of differential equations. Applications to the study of physical and engineering problems.

N.Papageorgiou

9.2.25.3 Complex Functions
(Mandatory, 3rd Semester)

Introduction to complex functions. Differentiation. Cauchy-Riemann equations and harmonic functions. Power series and elementary functions. Integration and integration formulae. Laurent expansions. Singular points. Use of computer programs.

N.Papageorgiou

9.2.48.3 Numerical Analysis and Laboratory
(Mandatory, 3rd Semester)

Computational arithmetic and round-off errors. Linear systems. Eigenvalues and eigenvectors. Non-linear equations and systems. Optimization. Mean squares method. Linear and non-linear programming. Approximation and interpolation of functions using polynomials and spline functions. Numerical integration. Introduction to the numerical solution of ordinary differential equations.

V. Kokkinis

9.3.03.3 Mechanics of Deformable Solids II
(Mandatory, 3rd Semester)

Differential equations of equilibrium and compatibility. Plane stress state. Prantl function of stresses for torsion of beams with random cross sections. Solution for torsion of beams with elliptical cross sections.

Bending of composite beams. Oblique bending of beams with cross sectional dual symmetry. Bending beams with cross sections with no axis of symmetry. Stress concentration.

Elastic line. Differential equation of the elastic line using moments, shear forces, loads and integration. Method of superposition. Solving hyperstatic beams using the elastic line.

Shear due to bending of beams with rectangular cross sections. Shear due to bending of beams with circular cross sections. Shear stresses on beams with “shoes”. Shear flow. The concept of shear center. Shear stresses in thin walled beams with open sections.

Principle of potential energy. Theorems of reciprocity. Castigliano Theorem. Solving hyperstatic beams with energy methods. Stiffness matrix. Buckling.

Elastoplastic bending. Elastoplastic Torsion

D. Eftaksiopoulos

9.4.85.3 Experimental Physics (Mandatory, 3rd Semester)

Theory and methodology of test measurements. Error theory. Analysis and presentation of test data.

Laboratory exercises: A total of ten (10) exercises on electromagnetism, wave mechanics, oscillations and optics of duration two (2) hours each will be carried out.

S. Thimi

1.14 4th Semester Courses

8.2.05.4 Mechanics of Fluids (Mandatory, 4th Semester)

Introduction, general properties of fluids. Hydrostatic, Archimedes principle. Kinematics of fluids. Integral form of the equations for mass, torque and energy conservation. Differential form of the equations of motion, Newtonian and non Newtonian liquids. Navier-Stokes and Euler equations. Dimensional analysis. Parallel flows. Boundary layers: the laminar boundary layer, the Blasius solution. Approximate calculation of boundary layers. Turbulent boundary layers. Resistance calculation. Boundary layer separation, resistance due to shape. Flow in pipes.

G. Triantafyllou

2.2.01.4 Thermodynamics I (Thermodynamics of a Single Variable) (Mandatory, 4th Semester)

Introduction and definitions. First and Second Laws of Thermodynamics. Perfect gas. Two-phase Thermodynamics. Real gases. Thermodynamic cycles.

E. Koronaki, E. Rogdakis

8.3.80.4 Electrotechnical applications and electrical laboratory for naval architects and marine engineers (Mandatory, 4th Semester)

Analysis of magnetic circuits, single- and three-phase transformers, fundamental operation principles of rotary electric machines, electric machine types, motors, brakes and generators (operation principles, single-phase equivalent networks), synchronous machines, asynchronous (induction) machines, Direct current machines, parallel operation of generators, motor-load combined operation, power electronics, basic principles of electric motor control

During the laboratory sessions the students deal with:

1. Performing operation tests in single and three-phase transformers
2. Operating rotating machinery
3. Simulating in computer environment the steady- and transient-state behavior of electric devices

J. Prousalidis

8.3.05.4 Machine Elements (Strength, Power transmission, Gears) (Mandatory, 4th Semester)

Load and stress analysis of shafts. Threaded fasteners. Belts. Springs. Tolerancing-Fits. Rolling contact bearings. Journal bearings. Clutches. Gears and gear sets. Elective elaboration of projects.

C. Papadopoulos

8.4.22.4 Materials Science and Technology II & Laboratory (Non-metallic materials, Corrosion) (Mandatory, 4th Semester)

Polymers, Ceramics and Glasses, Composite Materials and Wood. For each of the aforementioned group of non-metallic materials, are studied: classification, structure, properties, (physical, mechanical), degradation, forming techniques and applications.

Corrosion of metallic materials (Definitions, Introduction to Electrochemistry, Corrosion Potential, Kinetics of Corrosion, Passivation, Types of Corrosion). Methods for Protection against Corrosion. Corrosion of Marine Structures.

Laboratory Exercises:

Two laboratory exercises, including submission of technical reports:
a) "Corrosion potential measurements – Galvanic corrosion – Cathodic Protection"
b) "Anodic oxidation of aluminum"

D. Pantelis

9.2.29.4 Dynamics of Solid Bodies (Mandatory, 4th Semester)

Basic concepts and definitions. Kinematics of rigid bodies. Translation. Rotation. Angular velocity. Plane motion. Mechanisms. Relative motion. Coriolis acceleration. Dynamics of rigid bodies. Principles of dynamics. Mass. Inertia. Angular momentum. Work. Energy. D' Alembert's principle (potential work in dynamics). Conservation theorems. Conservative systems. Impact. Lagrange function and equations. Hamilton's principle. Euler's equations of motion of solid bodies. Balancing. Mechanical bending and torsional vibrations

Ch. Giounis

1.15 5th Semester Courses

8.2.20.5 Principles of Marine Hydrodynamics (Mandatory, 5th Semester)

Two-dimensional inviscid flows using complex functions. Flow about two-dimensional sections, lift coefficients. Flow about three- dimensional sections, vortices about wing edges – induced resistance. Linear theory of lifting surfaces and lifting line theory. Laminar boundary layer theory. Turbulent boundary layers. Form resistance of bodies – form resistance coefficient. Dimensional analysis and examples. Theory of trials and models. Dynamic similarity. Theory of gravity waves. Types of resistance - frictional and wave resistance, dispersion equation and undulation energy .

K. Belibassakis
G. Triantafyllou

8.2.11.5 Ship Resistance and Propulsion (Mandatory, 5th Semester)

Phenomenological methods, similarity theory, dimensional analysis, dynamic analysis, trial theory on models

Ship resistance, Traditional system for grouping resistance components and related nomenclature. Coherence resistance, pressure resistance, friction resistance, undulation resistance and related theories. Other resistance components. Effect of bulbous bow on resistance. Effect of resistance on the choice of dimensions and shapes coefficients of ship. Ship resistance estimation based on systematic series Experimental determination of resistance and modern experiment methods according to ITTC. Froude, Hughes methods and variations.

Dimensional analysis, similarity theory and phenomenological methods. Dynamic similarity and applications to model testing. Extension of model results to ships.

Ship Resistance: Traditional categorization and grouping of resistance components. Viscous resistance, viscous pressure resistance, frictional resistance. Wave making resistance and corresponding theories. Other components of ship resistance. Effect of bulbous bow to ship resistance. Experimental calculation of ship resistance, Froude method, Huge method and variants. Towing resistance experiments according to ITTC. Relation of hull form to resistance. Choice of ship dimensions and form coefficients. Determination of ship resistance using systematic series.

High speed crafts and advanced marine Vehicles. Resistance of planning crafts, method of Savitsky.

Ship propulsion: Self propulsion experiments and determination of propeller-hull interaction factors. Propeller geometry. Theories of propeller operation. Propeller design

using systematic series. Propeller cavitation. Types of main propulsion machinery. Other hydrodynamic propulsion devices.

Two laboratory exercises:

Experimental calculation of the

1. Experimental calculation of towing resistance of ship
2. Self propulsion experiment, propeller interaction coefficient estimation, experimental ship resistance prediction

G.Politis

8.4.10.5 Ship Strength (Mandatory, 5th Semester)

Longitudinal strength of monohull vessels. Bending in still water and waves. Classification society rules on longitudinal strength. Load distribution and deviations from simple bending theory. Normal stresses. Measurement of bending deflection of the primary structure of ships. Shear stresses. Other loads acting on the primary structure. Load and stress distribution. Secondary and tertiary stresses. Strength criteria (yielding, collapse, fatigue, buckling). Equations of dynamic equilibrium. Dynamic equilibrium of the primary structure. Eigenfrequencies of longitudinal vibration of the ship as a beam. Advanced vessel types: response of the primary structure. Stresses, classification society rules. Methods of analysis: elastic analysis of web frames. Plastic analysis of web frames. Lecture notes : "Ship Structures", E. Samuelidis, University Notes, NTUA.

E. Samuelidis

9.2.29.5 Partial Differential Equations and Boundary Value Problems (Mandatory, 5th Semester)

Fourier series. Sturm-Liouville problems. Inhomogeneous boundary problems. Fundamental differential equations of mathematical physics (Laplace, wave and heat transfer) in one, two, and three spatial dimensions (derivation of equations from physical laws). Classification of 2nd order pdes (elliptic, parabolic, hyperbolic). Well-posed problems. Boundary conditions. Boundary value problems (Dirichlet, Neumann, Robin). Solution of pdes. Separation of variables, Fourier transform. Introduction to calculus of variations. Variational formulations of boundary value problems. Complex functions: conformal mapping. Schwartz-Christoffel transformation, Poisson formula. Applications. Use of computer programs.

K. Kyriaki

V. Papanikolaou

9.2.70.5 Probability Theory and Statistics. Applications in the Marine Environment
(Mandatory, 5th Semester)

Concept and rules of probability. Random variables and their distributions. Basic models of probability distributions. Distribution parameters. Moment generators and their characteristic functions. Operations on random variables. Distributions of functions of several variables. Limit theorems. Introduction to stochastic processes. Stochastic nature of wind-generated waves at sea. The Pierson/Longuet-Higgins model. Second order stochastic processes and their parameters. Spectra. Spectral moments. Normal stochastic processes. Stationarity. Ergodicity. Differentiation and integration of second order stochastic processes. Sea waves treated as a normal stochastic field. Section and extreme value problems. Wave spectral parameters. Descriptive statistics. Estimators and their properties. Methods of point estimation. Confidence intervals. Statistical hypotheses testing. Regression analysis.

Computational exercises:

1: Stochastic simulation: Random variables and statistical tests

2: Random undulations. Random phase model.

Laboratory exercise: Generation and measurement of random undulations in the experimental tank of the School

G. Athanassoulis, I. Spiliotis

8.3.01.5 Introduction to Automatic Control Systems
(Mandatory, 5th Semester)

Basic principles: signals, systems, feedback, controller types. Laplace transformations. Physical systems mathematical modeling. Linear approximations. Transfer functions.

Mechanical systems, electromechanical systems. Transient response analysis for 1st and 2nd order systems. Stability of linear systems. Routh-Hurwitz method. Root locus. System analysis with the method of root locus.

Frequency response. Bode diagrams. Phase, gain margins. Design of compensators in frequency domain. PID controllers. Ziegler-Nichols method. Lead-lag controllers.

State space systems. Pole placement. Ackermann method. Optimal Control. LQ controllers. Digital control. Discrete transformations. Implementation of control systems: Hardware platforms, software, algorithms.

Design exercise homework using MATLAB/Simulink. Experimental demonstration.

G. Papalambrou

1.16 6th Semester Courses

8.1.30.6 CAD/CAM Systems for Ship Design and Construction (Mandatory, 6th Semester)

Introduction to use of CAD/CAM systems. Review of CAD/CAM systems. Interaction with user. Geometric databases, file management. Use of computers in CAD. CAM and CAE. Storage and transmission of data. Information technology applications in naval architecture and marine engineering. Three dimensional representations, parametric models, mathematical completeness of information, concurrent engineering. Development of computer-based drawings. Two-dimensional and three-dimensional geometric models of ship lines, general arrangement, structural elements and mechanical systems: discrete models, curves, surfaces, solids. Enrichment of geometric models with information on vessel construction and operation and in general with non-geometrical information using object-oriented programming. Drawing checks using arithmetical and geometrical techniques, representations and modeling techniques. Life-cycle ship drawings; processing and handling using computers. Transfer of drawings from paper to computer. Digitalization and reproduction of drawings (reverse engineering). Models for storage and management of drawings. Application to the exploitation, maintenance and repair of ships. Types and features of files: international standards, file transformation and error handling.

Laboratory exercises: One or two out of four laboratory exercises using commercial general purpose packages (e.g. AutoShip).

A. Gkinis

8.2.02.6 Ship Hydrostatics and Stability II (Mandatory, 6th Semester)

Waterproof division and stability after failure. Ship compartmentation. Flooding length. Stability after damage. Generalized method of lost buoyancy for arbitrary-shaped bodies. Basic principles of watertight subdivision and ship stability after damage. International SOLAS regulations. Required subdivision index R and achieved subdivision index A. Ship launching. Launching sites description. Launching calculations.

Two mandatory projects:

Calculation of flooding length

Calculation of flooding

K. Belibasakis

8.2.12.6 Ship Dynamics and Laboratory
(Mandatory, 6th Semester)

Dynamics of floating solid bodies. Coordiantion systems. Motion equations, when the coordination systems is in motion. Linearization. Inertia coefficients. Hydrostatic coefficients. Matrix form of ship equations.

Interaction of oscillating floating solid bodies and free surface undulations. Mathematical formulation of problem. Wave field. Diffraction and radiation problems. Hydrodynamic loading. Additional masses and floating masses amortizations. Calculation methods. Computer programs. Linearized motion equations in the frequency field. Response coefficients. Comparison with experimental data.

Hydrodynamic equations when the coordination system is in motion. Non linear free surface conditions. Permanent and non permanent wave field. Linearization and simples solutions. Free surface undulations as for the moving coordination system. Moving and oscillating point peculiarity field. Morphology of filed and meaning.

The problem of ship interaction with speed ahead and harmonic waves. General ship motion equations. Additional masses, amortizations, dynamic loading. Response coefficients. Symmetries. Horizontal and vertical motions. Calculation methods. Comparison of theory and experiment. Compartmentation and its suppression methods.

Dynamic response of ship in wind generated stochastic sea undulations. Input-output problem in the stochastic case. Undulations spectrum in a moving coordination system. Spectra and statistical measures of ship responses. Probabilistic characterization of dynamic responses. Section and maximum problems. Propeller cavitation. Deck impregnation. Hammering. Short and long term view.

Ship rudder: Symbolism adaptation. Motion equations. Rudder action. Hydrodynamic derivatives of bow and rudder. Analytical and experimental determination of hydrodynamic derivatives. Motion equations on the horizontal plane. Stability criterion, Reduction to a higher order equation. Nomoto equation. Ship rudder in a calm sea. Applications.

Computational exercises:

1. Ship rudder simulator
2. Dynamic response of model ship top harmonic and random waves in the experimental School tank.

G. Athanassoulis, G. Belibassakis

8.4.11.6 Ships Structures
(Mandatory, 6th Semester)

Introduction to the study of the metal structure of the ship. Bending and buckling of prismatic bodies. Shear lag. The concept of equivalent width plate in bending. Rectangular plates under bending loads. Buckling of rectangular plates. Behavior of reinforced laminates under compressive loads. The metal structure of various modern types of commercial vessels. The areas of the metal construction of modern commercial vessels. Design of cross sections. Design of the ship steel structure using basic principles of mechanics. Elements of theory of cylindrical shells. Application to the design of submarines. Reliability of marine structures.

Book: "The Steel Structure of Vessels. Local Strength Issues "P. Carydis, Athens, 2001.

P. Carydis

8.4.38.6 Dynamics of Marine Structures (Mandatory, 6th Semester)

Introduction to dynamics of structures. Free vibrations of linear systems of single and multiple degrees of freedom. Forced vibrations of linear systems of single and multiple degrees of freedom. Continuous systems. Approximate methods. Exact solutions. Elements of analytical dynamics. Use of the finite element method in dynamic response of marine structures.

I. Chatjigeorgiou

2.2.03.6 Heat Transfer I – General Principles and Applications (Mandatory, 6th Semester)

Introduction. Steady state and variable heat conduction. Convection. Radiation. Diffusion.

A. Sagia

2.2.04.6 Internal Combustion Engines I and Laboratory (Mandatory, 6th Semester)

Introduction. Energy flow (thermodynamics). Fuel flow. Gas flow. Applications.

K. Rakopoulos, D. Houdalas, E. Giakoumis

1.17 7th Semester Courses

8.1.10.7 Ship Design and Outfitting I – Methodology of Preliminary Design (Mandatory, 7th Semester)

Introduction and background literature. Ship design: aims, owners' requirements, design specifications, preliminary design methods and stages in ship design, design Optimization. Methodologies of preliminary selection of main dimensions and other characteristics: estimation of displacement, main dimensions and form coefficients, powering requirements, weight groups. Improved methods for the calculation of displacement and weight groups (modeling by data of similar ships, statistical methods, method of Normand, displacement equation). Displacement control. Hull form development. Hold capacity. Tonnage regulations. Loadline and freeboard rules. Stability and trim rules: SOLAS safety regulations, grain loading regulations. Propulsion, machinery and manoeuvring equipment. Preliminary estimate of construction cost.

Examples:

- Application of loadline rules
- Application of SOLAS stability regulations.
- Application of tonnage measurement regulations
- Case studies in preliminary ship design

A. Papanikolaou

8.1.15.7 Ship Design Project I (Mandatory, 7th Semester)

Selection of main dimensions and form coefficients. Preliminary estimation of powering requirements and selection of propulsion machinery. Lightship and fully outfitted (unloaded) displacement calculations. Safety regulations (stability). Preliminary capacity estimation and loadline requirements. Lines plan and preliminary general arrangement. Hydrostatic stability calculations, hydrostatic curves, stability curve, cross-curves of stability, floodable length curves. Application of subdivision rules. Resistance calculation, selection and design of propeller and rudder. Structural design of midship section using classification society rules. Midship section plan. Longitudinal shear force and bending moment diagrams in still water and waves. Cost construction estimate.

G. Zarafonitis, P.Karydis, N.Tsouvalis, K. Belibassakis. and other faculty members

8.1.20.7 Economics of Maritime Transport I (Mandatory, 7th Semester)

Elements of the theory of production and consumption. Investment evaluation criteria. The charter market. The concept of perfect competition. Types of charters and charterparties. Tanker chartering. Spot market freight rates. Market structure. Institutional framework. Time charters. The dry cargo charter market. The oil distribution network. Freight rates and prices in the oil market. The liner trade. Conferences. Cost structure. Monopoly freight rates. Institutional framework. Internal competition. Components of transport cost. Intermodal transport. Container transport. Ports as transhipment nodes. Elements of the theory of international trade.

N. P. Ventikos

8.3.10.7 Ship Systems and Marine Auxiliary Machinery (Networks, Hydraulic Systems, Deck Machinery) (Mandatory, 7th Semester)

Introduction to ship systems. Pipes and fitting. Piping calculations: internal diameter and standardised diameter, wall thickness, hydraulic test pressure, pressure loss, piping insulation. Piping materials: electrochemical corrosion, properties and use of different materials. Pumps and pumping. Description of ship piping systems: compressed air, fuel transfer, purification of fuel oil, lubricating oil, fresh water, cooling, auxiliary boiler steam, main steam supply, tank, fire, ballast, seawater, fresh water, ventilation, overflow, measurement, cargo. Crude oil washing (COW) and inert gas systems (IGS). Heat exchangers. Refrigeration and air conditioning. Fire extinguishing systems. High pressure hydraulic systems. Auxiliary machinery: deck machinery, steering gears stabilizer equipment.

The course includes the preparation of elective projects.

L. Kaiktsis

8.3.12.7 Marine Propulsion Plants (Mandatory, 7th Semester)

Introduction to marine engineering. Requirements of a propulsion plant. Limitations. Engine room arrangements. Basic principles of propulsion, ship resistance characteristics propeller torque requirements. Torque supply characteristics of various types of prime movers (steam turbine, gas turbine, diesel). Propeller-engine matching. Engine reversal. Marine diesel engines. 2-stroke, 4-stroke, Scavenging, Turbocharging, Emissions. Auxiliary systems. Thermal balance, heat recovery. Selection of main engine. Economic and technical study of propulsion plants. Fuels and lubricating oils. Torsional vibrations. Shafting systems.

N. Kyrtatos

8.3.39.7 Dynamics and Vibrations of Ship Machinery and Shafting Systems (Mandatory, 7th Semester)

Modeling of power transmission and piston motor mechanism and dynamics. Turning oscillations and fatigue of shafts, discs, gearbox, brakes and clutches. Support bearings, balancing and aligning of shaft systems and discs, Modeling of bearings and vibration isolation between machinery and main construction. Waves in axis. Dynamic fracture of shafts and discs with cracks. Modeling and dynamics of lifting machinery.

I. Georgiou

8.4.20.7 Shipbuilding Technology and Laboratory (Mandatory, 7th Semester)

Shipbuilding materials (steels, aluminum alloys, titanium alloys, composite materials). Brittle fracture (phenomenology, principles of linear elastic fracture mechanics, avoidance of brittle fracture). Fatigue (phenomenology, cyclic stress method, application of linear elastic fracture mechanics to fatigue, shipbuilding applications). Lamellar tearing. Elements of welding engineering (description of welding techniques, welding defects, non-destructive testing methods, welding strength calculations). Planning and control of shipyard production.

Three series of exercise for solution at home

Laboratory: Three laboratory exercises

N. Tsouvalis

1.18 8th Semester Courses

A) Mandatory courses

8.1.11.8 Ship Design and Outfitting II (Detailed Design) (Mandatory, 8th Semester)

Introduction and background literature. General arrangement: design procedure, cargo spaces, special provisions for refrigerated cargo, engine room, accommodation spaces, tanks. Design of accommodations and lines of communication. Cargo handling and mooring equipment: conventional and innovative technologies. Ro-Ro, SEABEE and LASH concepts. Design of containerships. Advanced Marine Vehicles. Regulations concerning fire and life saving equipment. Design of bulk carriers and peculiarities of grain carriers. Oil tanker design, OPA 90 and MARPOL regulations. Recent developments of SOLAS regulations. Design of passenger/ferry ships.

Examples:

- Stability booklet and inclining experiment.
- Grain loading calculations.
- Fire safety regulations.
- MARPOL regulations.
- Safety equipment regulations.

A. Papanikolaou, K. Spyrou

8.1.21.8 Economics of Maritime Transport II (Mandatory, 8th Semester)

Methodology of decision making under conditions of uncertainty. Application to maritime transport. Coastal shipping. The Greek coastal shipping system. EU regulations on cabotage. Short-sea shipping. Competition with other means of transport. Port competitiveness. Advanced intermodal transport systems. The role of advanced technology. Institutional matters in Greece and the EU. Case studies in maritime transport.

N. P. Ventikos

8.3.20.8 Energy Systems of Ships (Mandatory, 8th Semester)

Electric Installations of Ships: requirements for ship electrical equipment; operating voltage and frequency; rules and regulations; electric balance; generator selection, parallel

operation and load sharing; electric circuits on ships; short circuit calculation studies; main issues and state-of-the-art in electric propulsion and All Electric Ship.

Steam Propulsion Plants: description of typical installations, energy analysis of steam propulsion plants, marine boilers, marine steam turbines.

Marine gas turbines: types of gas turbines, configurations of systems comprising gas turbines, thermodynamic analysis, estimation of emissions, operating characteristics.

Fuel cells: basic principles, types, technical characteristics, appropriate fuels, system configurations, prospects for applications on ships.

Magnetohydrodynamic propulsion: basic principles, types, technical characteristics, prototypes of systems.

Energy savings and alternative energy sources on ships: improvements of hull, propeller, and main engines; energy recovery; the concept of the integrated energy systems; alternative energy sources; procedure for economic evaluation.

J. Prousalidis

B) Elective Courses –Thematic Units

Thematic Unit A: Marine Environment and Interaction with Ships and Floating Structures

8.4.35.8 Design of Floating Structures
(Elective Course, 8th Semester)

Consecutive stages in the design of floating and offshore installations. Description of environmental data (wind, currents, waves). Determination of loads arising from environmental factors (wind, currents, waves). Morison equation and application to hydrodynamically thin, rigid, and deformable structures. Hydrodynamic analysis using three-dimensional dynamic flow theory. Problems of diffraction and radiation. Exact and approximate methods. Hydrodynamic analysis of semi-submersible offshore platforms. Examples.

S. Mavrakos

8.1.42.8 Course Stability and Maneuverability
(Elective Course, 8th Semester)

Maneuvering and course stability considerations in ship design. Specific requirements and problems by type of vessel. Development of linear and nonlinear models. Determination of satisfactory behavior criteria. Course stability using active steering control. Ship manoeuvring and course keeping in restricted waters. The problem of squat in shallow water. Other environmental effects. Developing a model for the stopping maneuver.

Influence of design parameters. Criteria for satisfactory behavior within and out of the framework of international regulations.

The course includes a laboratory exercise in a maneuvering motion simulator.

K. Spyrou

8.2.27.8 Computational Fluid Dynamics (Elective Course of Group C, 8th Semester)

Introduction to CFD. Examples of numerical simulations in marine hydrodynamics. Governing equations. Turbulence models for hydrodynamic applications. The control volume approach. Pressure correction methods. Solution algorithms. Solution of the resistance and propulsion problems. The actuator disk model. Generation of computational grids using conformal mapping techniques. Curvilinear coordinate systems. Free surface problems. Flows about hydrofoils, submarines and ships.

G. Tzabiras

8.2.37.8 Stochastic Modeling and Forecasting of Marine Systems. Application to Ship Dynamics (Elective Course of Group C, 8th Semester)

Deterministic and stochastic experiments. Probability space. Multidimensional random variables, calculation techniques, stochastic convergence. Large Numbers Law and Central Limit Theorem

Stochastic functions and fields. Probabilistic characterization, basic sorting, second order stochastic processes, normal stochastic processes, stationary stochastic processes. Mean quadratic calculus (integration, differentiation), Ergodicity and mean quadratic concept. Marklov processes, Chapman-Kolmogorov equations, diffusion processes, Fokker-Plank equations, jump processes, Master equations, independent increment processes, spectral presentation for stationary stochastic process of 2nd order. Non stationary models.

Linear transformations of stochastic processes, linear systems responses under stochastic stimulation. Modeling methods for studying non linear systems under stochastic stimulation. Analytical properties of sample functions. Section and maximum value problems and applications in statistics and optimization for system design.

Stochastic sources in mathematical paradigms of environmental phenomena. Stochastic initial conditions. Stochastic stimulation, coefficients and differential equations. Statistical theory of turbulence - introduction. Stochastic modeling of sea dynamic phenomena.

Computational exercise: Simulation of random processes (various models), Extreme values of random functions.

G. Athanassoulis

8.2.14.8 Ship Behavior in Waves and Applications (Elective Course of Group C, 8th Semester)

Long term stochastic view. Long term maximum value estimation and loading and motion design values. Classification Society regulations. Additional resistance and random events. Intentional non intentional reduction of speed in waves. Effect of motions of ships on the passengers and crew, comfort criteria, questionnaires. Operational efficiency. Route selection based on weather forecast and sea. Effect of bow shape on the dynamic behavior in undulations. Compartmentation amortization and its suppression methods. Behavior tests in undulations (on ship, with models in the laboratory and in the sea. The course includes a project of analytical calculation of the area of allowed ship operation using strip theory.

G. Gregoropoulos

Thematic Unit B: Study, Design and Construction of Ships and Floating Structures

8.1.16.8 Ship Design Project IIa (Elective Course, 8th Semester)

Estimation of requirements and distribution of spaces – development of integrated general arrangement (simplified engine room). Volume curves. Trim and stability booklet. Application of damage stability regulations (SOLAS 90, probabilistic approach A.265, selection). Structural design using classification society rules. Constructional profiles and decks plan. Midship section design using first principles approach. Detailed design of one ship section using classification society rules. Fire or safety appliance or MARPOL rule application. Construction specification and shipbuilding contract. Production planning of one structural section. Economic and technical investment analysis.

G. Zarafonitis and other faculty members

8.4.23.8 Structural Analysis and Design of Composite Materials Vessels (Elective Course, 8th Semester)

General introduction to composite materials. Mechanical and physical material properties and composite materials manufacturing methods. Classical lamination theory. Failure modes and failure criteria of composite materials. Laminate strength. Structural analysis and design principles of composite material vessels. Bending and buckling of hat-type stiffeners and laminated plates. Design of joints. Example of the structural design of a composite materials planning craft.

Exercises: Three elective exercises requiring use of specialized software for analyzing the mechanical behavior of composite materials.

Laboratory exercise: One mandatory laboratory exercise of 5 hours per student, requiring the submission of a technical report.

N. Tsouvalis

8.4.25.8 Welding Science and Technique (Elective Course of Group C, 8th Semester)

Introduction. Welding methods. Electrical arc physics. Material transfer and electrode melting during welding. Heat supply and heat transfer in welding. Residual stresses in weldings. Deformations in welded structures. Mechanical behavior of welded structures. Weldment quality control. Welding cost. Fe-C binary system. Metallurgical phenomena in welding. Common carbon steel welding. Stainless steel welding. Aluminum alloys welding. Advanced welding techniques (friction welding, laser welding, etc.)

D. Pantelis

8.4.27.8 Health and Safety in Shipbuilding (Elective Course of Group C, 8th Semester)

Introduction to health and safety at work. The legal framework in Greece. The institutional framework. Causes and consequences of labor accidents. Environmental management and safety at work. Assessment of danger at work. Safety management. Layout of the working environment. Physical parameters, dangers and methods of approach. Chemical parameters, dangers and methods of approach. Diseases at work. Fire protection. Ergonomy. Health and safety in ship repair work.

I.Chatzigeorgiou

8.1.13.8 Shipbuilding for Safety and Environmental Protection (Elective Course of Group C, 8th Semester)

Introduction to the design of mechanical systems safety. Traditional and modern view of safety in process design. Risk concept. Determination of risks and consequences. Analysis of methods for quantitative and qualitative risk estimations.

Classification society rules and IMO conventions. Critical design issues. Stability, loading maneuvering, pollution prevention, fire safety, rescue, evacuation. Mathematical models on safety issues and behavior prediction. Probabilistic view. Formal safety assessment frame for development of new rules. Case studies on ship safety.

Specialized safety issues and environmental protection for each ship type, tankers, passenger ships, ferries, bulk-carriers.

K. Spyrou

8.1.36.8 Applications in Ship Design
(Elective Course of Group C, 8th Semester)

Computer graphics. Virtual reality tools. Human factors. Computational systems architectures. Virtual Reality Modeling and user interface interaction. Virtual Reality Programming environments and applications- Laboratory

A. Gkinis

Thematic Unit C: Marine Engineering and ship propulsion

8.3.15.8 Marine Diesel Engines
(Elective Course, 8th Semester)

Marine diesel engine design and construction. Engine general design. Slow speed and medium speed engines. Fuel injection systems, combustion. Power increase and turbo charging. Construction of turbochargers, turbine characteristics, compressors. Matching of main engine with turbocharger. Turbocharger systems. Two-stage turbocharging. Variable geometry. Power turbines. Hot engines. Turbocharger Upgrading and Retrofit. Transient behavior of main engine. Mathematical model of propulsion system. Heavy fuel oils and related problems. Lubricants. Main engine mounting. Engine shop trials. Ship trials. Maintenance and condition monitoring. Crankcase explosions. Scavenge box fires. Engine emission reduction methods. Developments in diesel engines.

N. Kyrtatos

8.3.61.8 Marine Engineering Laboratory I
(Elective Course, 8th Semester)

Introduction to the fundamentals of measurements, standardization of weights and measures in the SI system, calibration of measuring devices.
Laboratory Exercises:
1. Measurements of Pressure, Temperature and Flow
2. Measurements of the Transfer Function of Automatic Control Systems
3. Measurements of Torsion, Bending and Thrust in Shafts
4. Measurements of Acceleration and Forces
5. Measurements of Viscosity.

N. Kyrtatos, Ch., I. Georgiou, L. Kaiktsis, ,
N. Alexandrakis, G.Papalambrou

8.2.13.8 Modern Ship Propulsion Hydrodynamics
(Elective Course, 8th Semester)

Modern non conventional propulsion systems, loss mechanisms and energy conservation.

Numerical calculation of ship resistance including free surface effects. Numerical simulation of a self propelled ship. Use of modern CFD methods to the propulsion optimization problems for various ship types. Effect of form to the resistance and propulsion characteristics of submarines. Numerical calculation of propeller-hull interaction factors. Effect of scale.

Propeller geometry. Effect of propeller to its hydrodynamic performance (efficiency, cavitation, noise and vibration).

Analytical calculation of propeller geometry, optimum design and performance problems. Selection of propeller geometry in analytical propeller design.

Effect of nozzle in propeller performance, types of nozzles. Contra rotating and tandem propellers. Controllable pitch propellers. Pod propulsion. Pump jet propulsion. Vertical axis propellers. Magneto-hydrodynamic propulsion. Water jets.

Modern non-conventional propulsion systems. Efficiency improving propulsion devices. Grim wheel. Wake equalizing duct. Various types of spoilers. Bulbous rudder.

Propeller cavitation. Types of cavitation and relation to propeller blade geometry. High speed propulsion devices, supercavitating propellers, surface piercing propellers.

Computational exercise on analytical design of a propeller via CFD methods and computer code generated by the instructor.

G. Politis

8.3.45.8 Special Ship Control Systems (Elective Course, 9th Semester)

Short historical review of control systems for ships. Review of MATLAB/Simulink.

Review of feedback control: transfer functions and state space equations. Specifications of 1st and 2nd order systems. PID controllers, optimal controllers (LQ), self-tuning controllers (ST). Kalman filters.

Ship control systems: Course autopilots. Fin stabilization. Rudder-roll stabilization. Sensors, actuators. Controller examples: PID, LQ, STR.

Engine control systems: Speed control, governors, common rail systems. Variable geometry turbine control. Variable valve timing control. Controller examples: PID, LQ, STR.

Controllable Pitch Propellers. Combinators.

Engine monitoring and alarm systems. Simulated example.

Simulation of ship control systems in MATLAB/Simulink.

Design exercise homework using MATLAB/Simulink.

G: Papalambrou

8.2.40.8 Measurement of Physical Quantities in the Marine Environment (Elective Course of Group C, 8th Semester)

Theory: measurements statistics. Error theory. Statistical analysis and correlation of dependent quantities. Presentation of measurement data. Planning and execution of experiments. Comparative experiments. Multi-parameter experiments. Modeling experiments. Computer applications in modeling. Direct connection of computers on a data acquisition network for the collection and processing of signals in real time. Data evaluation and analysis. Recording and analysis of samples of stochastic processes. Spectral analysis. Digital filters. Measurements in the maritime environment. Laboratory measurements. Decision-taking systems.

Laboratory exercises: Network layout, acquisition, processing and analysis of records in the NTUA Towing Tank. Use of data acquisition software. Statistical reliability tests.

G. Grigoropoulos, E. Hinis

Thematic Unit D: Ship Operations and Sea Transport Systems Management

8.1.26.8 Introduction to Finance. Special Topics in Shipping Finance (Elective Course, 8th semester)

Introduction to finance. Present value and cost of capital. Investment decisions. Risk and return. Planning of capital availability. Financing of large companies. Share policy and capital structure. Shipping investments. Sources of capital, bank lending, capital markets. Risk management.

N. P. Ventikos

8.3.56.8 Sensor Technology - Diagnostics and Prediction of ship machinery failures. (Elective Course of Group C, 8th Semester)

Introduction. Description of dynamical systems with input/output relation and state space. Integral transformations and spectral analysis. Measurement process, use of filters. Logical systems and circuits: Combinatorial and sequential circuits, algorithmic state machines, micro controllers.

Sensor measurement technology. Principle of sensors with coupling of mechanical variables with electric- magnetic and variables. Encoders. Distortion sensors and piezoelectrical, fiber optic, laser and photoelasticity sensors. MEMS systems, mechatronics. Detailed analysis of position, speed, acceleration, force, pressure sensors as dynamic systems.

Reduction and recognition of order of dynamic systems. Reduction of order of dynamic systems with orthogonal projections and geometrical peculiar perturbations. Parametric recognition of input/output relation. Non parametric recognition of signal processing with FFT transformations, optimum least square filters. Wiener-Kalman filters, ARMA models. Non linear recognition by means of neural networks and non-linear Wiener-Volterra systems.

Diagnostic methods of ship machinery failures. Classical diagnostic methods with statistical processing and pattern recognition methods, closest neighbor rules, principal component analysis. Time series corruption sensitivity indicators. Reconstruction of phase space from experimental data. System failure position spotting of system. Computational intelligence methods: Correlation methods with neural networks, fuzzy logic.

Applications: Laboratory exercise on failure diagnosis and vibration and noise isolation:

1. Recognition and diagnosis of failures in bearings and gears.
2. Recognition and diagnosis of failures in fractures on elastic axles and discs.
3. Recognition of vibrations and noise for active and passive control

I. Georgiou

8.1.28.8 Ports and Intermodal Transport (Elective Course of Group C, 8th Semester)

Study of the functions of ports and presentation of their role in the chain of intermodal transport. Presentation and analysis of issues related to the management, design and development of ports, loading and unloading and cargo handling and implementing of relevant optimization methods. Institutional port models. The ISPS code for ports' security. Ports' competitiveness and market access to port services. Recording of institutional and other developments in international and Greek area. Vessel traffic management, interface ship-port, and environmental improvement and immunity

N. P. Ventikos

8.2.41.8 Artificial and Computational Intelligence in Design and Operation of Ships (Elective Course of Group C, 8th Semester)

Introduction to the basic principles of development and operation of Artificial and Computational Intelligence systems. Summary centralized and distributed intelligence. Knowledge (structure, performance, handling), reasoning, intelligent behavior. Presentation of the structure, operation and use of modern software systems that are based on knowledge and that may allow the easy incorporation of rules, regulations, empirical directives and other various restrictive provisions.

Genetic algorithms and evolutionary systems. Genetic structures and evolutionary operators. Parameters of evolutionary systems. Behavior and convergence of evolutionary

systems. Optimization and other applications of evolutionary systems. Other techniques (Neural Networks, Fuzzy Logic, self-organized systems). Fuzzy systems, meta-heuristic techniques, artificial immune systems. Applications in the design and ship operation. Hull form optimization using Computational Intelligence and HS. Support in designing ship systems.

Presentation and laboratory familiarity with two expert systems that support the loading of ships and the development of optimal routing of ships.

The course includes two laboratory exercises.

G. Grigoropoulos

8.1.24.8 Risk Theory, Engineering and Applications in Maritime Transport (Elective Course of Group C, 8th Semester)

Introduction to the study and management of risk theory and risk engineering: focus is given on individual risk, societal risk, perceived risk, environmental risk, and risk benefit approach for maritime transport. Comprehensive survey of the dimensions of risk and of risk acceptance criteria, through the presentation of relative theories, methodologies and suggestions. Quantitative risk assessment (QRA), and risk based decision making and decision reasoning is also part of the curriculum of this lesson. Comparative presentation of risk oriented approaches and studies of various (transport) industries with a special focus on maritime transport applications.

N. P. Ventikos

1.19 9th Semester Courses

A) Elective Courses -Thematic Units

Thematic Unit A: Marine Environment and Interaction with Ships and Floating Structures

8.4.36.9 Mooring of Floating Structures (Elective Course, 9th Semester)

Types of mooring systems. Permanent and temporary mooring systems. Description of mooring system components (legs, anchors, materials). Static analysis of single and multi-leg ship mooring systems. Equation of the inelastic and elastic catenary, intermediate flotation tanks, use of different materials). Design of single and multi-leg mooring systems (wind design loads, currents and waves acting on the floating structure, preliminary selection of geometric and inertial characteristics of legs, determination of mooring system stiffness, response of moored structure, load-response curve, capability requirements). Regulations concerning design of mooring systems (classification societies etc).

S. Mavrakos, I. Chatjigeorgiou

8.2.15.9 Hydrodynamic Design of Small Craft (Elective Course of Group C, 9th Semester)

Part A. Fast craft. Introduction and description. Semi-displacement vessels. Planing and other types of small craft. Estimation of resistance of fast craft. Semi-empirical methods. Savitsky method. Systematic resistance series of hull forms of semi-displacement and planing vessels. Propulsion of fast craft. Dynamic behavior of fast craft in waves. Elements of fast craft design. Part B. Sailing vessels. Geometrical considerations in sailing vessels. Forces acting on sailing vessel hulls. Analysis of resistance components. Stability and seamanship. Efficiency equations for sailing vessels. Experimental determination of sailing yacht performance. The VMGMAX-VT diagram and Gimcrack coefficients. Design of sailing hull forms, appendages and sail outfitting. Systematic series for sailing vessels.

The course includes one laboratory exercise with a mandatory technical report compilation.

G. Grigoropoulos

8.1.41.9 Heeling Stability and Regulations background. (Elective Course, 8th Semester)

Separation between dynamic stability and static stability. Relation with the classical stability theory. Development of mathematical models of roll motion of a ship under the influence of wind and wave. Analysis of known phenomena of dynamic instability: resonance in lateral waves, parametric instability, genuine loss of stability and broaching in longitudinal waves. Combatting instabilities with design and operational means. Regulatory requirements and recent developments. Probabilistic and deterministic principles for the response to instability after damage. Evolution of regulations.

The course includes the preparation of laboratory exercises.

K. Spyrou

8.2.29.9 Wave Phenomena in the Sea Environment (Elective Course of Group C, 9th Semester)

The marine environment and wave phenomena. Physical properties of seawater. Overview of basic concepts and equations of fluid mechanics. Wave equations of dynamic phenomena occurring in the marine environment (gravity waves, acoustic waves). Analytical solutions of wave equations in simple cases (plane wave, cylindrical wave, spherical wave, point sources of waves in free space and in wave generators). Basic wave phenomena: confluence, reflection, refraction, diffraction, Huygens' principle. General methods of solution of wave equations (analytical, semi-analytical, numerical, hybrid). Geometric wave mechanics (theory of radii). Equations of geometric wave mechanics as a high-frequency asymptotic approximation to wave equations. Equations of radii. Wave breadth equations (for gravity and acoustic waves). The Hero-Fermat principle. Alternative approach to the development of geometric wave mechanics. Analytical solutions of geometric wave mechanics. Refraction in inhomogeneous media with a slowly varying refractive index. Radii in layered media. Acoustic channels at sea. Special topics in the transmission of sound waves in shallow water. Special topics in the transmission of gravity waves in shallow water.

Exercise: "Computational simulation of wave diffusion in waveguides"

K.Belibassakis
G. Athanasoulis

8.2.25.9 Lifting Flows (Elective Course of Group C, 9th Semester)

Introduction. Linear algebra and the theory of determinants. Definition of tensors, tensor algebra, tensor analysis, tensor fields, intrinsic derivative, covariant derivative, integral

theorems. Kinematics and dynamics of fluid mass. Euler, Navier-Stokes, and vorticity equations (in curvilinear co-ordinate systems). Helmholtz theorems and vorticity kinematics and dynamics.

Qualitative study of the flow around a solid body with lift. Methodology, wake models, kinematics and dynamics of free vortex sheets. Bound vortex sheets. Joukowski hypothesis and Kutta conditions.

Representation theorems for potential and velocity.

Modern boundary integral equation formulation for flows around bodies with lift. Application of the method to the solution of the lifting flow problem about a 2-D and a 3-D body of any geometry with lift. Hess and Smith and Morino formulations.

G. Politis

Thematic Unit B: Study, Design and Construction of Ships and Floating Structures

8.1.35.9 Computer-Aided Ship Design (Elective Course, 9th Semester)

Review of linear and non-linear programming techniques. Ship design and preliminary design formulated in non-linear programming terms. Fairing of groups of two-dimensional curves (e.g. frames, waterlines). Fairing of groups of two-dimensional curves and surfaces. Use of commercial design packages (TRIBON, AutoCAD).

A. Gkinis

8.4.26.9 Reliability of Marine Structures (Elective Course, 9th Semester)

Introduction. Basic concepts of structural reliability theory (basic reliability model, parameters and failure surfaces, reliability indices, reliability calculation of a structural member). System reliability models (parallel and series, combined systems, composite systems, levels of reliability). Partial safety factor evaluation. Time varying reliability. Application to marine structures.

Faculty member

8.4.17.9 Ship Vibrations (Elective Course, 9th Semester)

Vibration of primary hull structure. Eigenfrequencies of bending vibrations in the vertical and horizontal planes and in torsion. Bending response to regular and random wave excitation. Vibrations of superstructures and aft end structures. Vibrations of structural members. Excitations: main engine, propeller, wave action. Classification society rules on design and vibration avoidance.

E. Samuelidis

8.4.40.9 Applications of Computational Methods in Ship Structures (Elective Course of Group C, 9th Semester)

Energy methods in structural analysis. The finite element method. Isoparametric finite elements. Finite elements for thin-walled structures. The Rayleigh-Ritz formulation and interpolations. The use of the FEM in structural analysis. Ship structural analysis and design using FEM commercial packages. The MAESTRO program and it's application to the design of a new vessel. The finite difference method. Dynamic relaxation. Errors of computational methods.

P. Caridis

8.4.12.9 Analysis of Metal Constructions in Marine Structures in the Elastoplastic Region (Elective Course, 9th Semester)

Behavior of isotropic materials in the elastoplastic region – yielding under multidimensional stress state. Maximum load. Upper and lower boundary theorems. Plastic analysis of beams and frames under transverse, uniform or non uniform loads. Plastic analysis of plates under transverse, uniform or non uniform loads. Plastic analysis of reinforced plates under transverse, uniform or non uniform loads. Fracture of axial elements. Application in estimating the fracture of the bow and the vertical elements of a double hull (bases and grades). Effect of the shear stress at the maximum plastic strength. Ductile fracture models. Stressing of construction elements- beams, plates-, under dynamic loading. Effect of deformation rate and temperature on the properties of materials. State equations in the elastoplastic area. Stepwise formulation under multidimensional stress state. Ultimate Limit State, Accidental Limit State. Examples of estimation of the behavior under limit loads: beams, plates, reinforced laminae, hull. Regulation requirements.

E. Samuelides

Thematic Unit C: Marine Engineering and Ship Propulsion

8.3.60.9 Marine Engineering Laboratory II (Elective Course, 9th Semester)

Laboratory Exercises:
1. Parallelism generator sets in Network
2. Thermal Balance of Diesel Engines
3. Efficiency of Centrifugal Pumps
4. Sub-depression stills
5. Shafting system alignement
6. Control System Design of Inverse Pendulums
7. Torsional Vibrations.

N. Kyrtatos, I. Georgiou, L. Kaiktsis, J. Prousalidis, C. Papadopoulos N. Alexandrakis, G.Papalambrou

8.3.35.9 Noise and Vibration Technology in Naval Architecture and Marine Engineering (Elective Course, 9th Semester)

Revision of basic concepts of dynamics of the harmonic oscillator. Vibration analysis of systems with two and three degrees of freedom and numerical integration of equations of motion. Basic wave phenomena in elementary elastic continua (rod, axle, beam), wave-vibration relationship, energy transfer, confluence, reflection, echo, wave transmission, diffusive and non-diffusive media. Basic wave phenomena in fluids. (air, water), sound, sound intensity, sound sources, sound waves and noise, decibel scale. Basic concepts of interaction of sound waves with structures, emission and transmission of sound. Basic concepts in the study of energy flow in coupled structures. Analysis of vibration and noise signals, Fourier series, the continuous and discrete Fourier transform, analysis of vibration time series using modeling and measurements using the *FFT* algorithm. State-of-the-art technologies for the measurement and control of vibrations, smart materials. Applications: accelerometer, seismograph, automatic control of structures, torsional vibrations of shaft systems, vibration of propeller blades, isolation of machinery vibrations, diagnosis of equipment damage, sensor-structure interactions, converter-structure interaction, control of noise and vibrations on board ships, fatigue and failure of components, sound-insulating materials, elastic foundations.

I. Georgiou

8.3.21.9 Combustion
(Elective Course of Group C, 9th Semester)

Elements of kinetic theory of gases, basic concepts of transport phenomena. Chemical thermodynamics, introduction to chemical kinetics. Explosive and oxidative characteristics of fuels. Premixed flames, diffusion flames, ignition, formation of pollutants. Applications (combustion in boilers and internal combustion engines)

The course includes the preparation of elective projects.

L. Kaiktsis

Thematic Unit D: Ship Operations and Sea Transport Systems Management

8.4.50.9 Inspection, Repair and Maintenance of Ship Structures
(Elective Course, 9th Semester)

Corrosion, fatigue, buckling and cracks and their effect on the strength and maintenance of ship structures. Damages to the structure of bulk carriers and oil tankers. Repair of cracks and other local damages. Surveys of the hull structure, hull life extension programs. Hull structure surveys of bulk carriers and oil tankers. Maintenance planning and techniques (protective coatings, cathodic protection). Strategic maintenance planning of the hull structure using thickness measurement databases. Examples.

P. Caridis

8.1.27.9 Logistics in Maritime Transport
(Elective Course, 9th Semester)

Introduction to logistics, historical review. International transportation system. Modern requirements of companies and strategy. Methods and solutions. Operational strategies. Selection of transportation means. Nodal stations-warehouses. Intermodal transport. Institutional framework and policy. Examples.

D. V. Lyridis

8.1.29.9 Economics of Maritime Transport III: Environment and Safety Analysis
(Elective Course of Group C, 9th Semester)

Analysis of maritime transport safety and marine environment protection, with emphasis on operations, economics and managerial issues. Casualty analysis theory. Introduction to

Formal Safety Assessment. Oil pollution and the "weathering" of the spill. Means and strategies for oil spill confrontation: introduction into the set up and assessment of oil response operations. Internalization of external costs. Air emissions and analysis of alternative scenarios. The ISPS code for ship and port security.

N. P. Ventikos

8.1.23.9 The Human Element – Introduction to Human Reliability for Maritime Transport (Elective Course of Group C, 9th Semester)

Study of human element and introduction into human reliability for maritime transport. Quantification and assessment of the role of human factor in terms of safety and efficiency of maritime transport. Presentation of first-generation and second-generation human reliability methodologies and applications of them within maritime transport. The human element is integrated as a hazard but also as a potential risk control measure: in effect reference to the modern holistic approach of human factor is made. Critical review is done regarding human reliability applications and their usefulness for maritime safety is assessed accordingly.

N. P. Ventikos

1.20 Description of Group A Courses

A.1

School of Applied Mathematics and Physical Sciences (SAMPS) / DHSSL

9.1.21.1 Sociology of Science, Technology and Civilization (Elective Course of Group A.1, 1st Semester)

Aim of the course a sociological approach of science and technology. A condition for this is the interaction between technology and social institutions. There is a focus on large technological systems and networks of the 20th century in Europe and USA, social relations affecting science, communication networks, reward systems, financing schemes of scientific research and the male and female scientist figure.

K. Theologou

9.1.31.1 Political Economy (Elective Course of Group A.1, 1st Semester)

Schools and principles of the science of economics.

1. Economic variables and definitions. Inflows and outflows of production process. Initial and final inventory of production means, intermediate inflows. Gross and Net Product, intermediate flows and Gross Production Value. Net Product distribution and amortization. Nominal and Real wage, gross investment.
2. Introduction the Macroeconomics theory. Elements on Microeconomics and Neoclassical theory and its basic concepts. Supply and demand of goods. Elasticity of demand. Supply of goods. Elasticity of supply. Balance. Transposition of supply and demand curves
3. Theories on demand. Consumer behavior. Absolute Utility theory.
4. Theories on production and production cost. Production theory.
5. Market structures. Introduction. Perfect competition. Monopoly. Monopolistic competition. Oligopoly
6. Principle of active demand. Keynes and active demand.
7. National accounts. Closed economy without a state. Closed economy with a public sector.
8. Determining factors of revenue. Consumer expense. Interest rate and money market.
9. IS-LM model. Introduction. IS curve, LM curve. Budget and monetary policy. Extension of the model.

I. Milios,
P.Michaelidis

9.1.41.1 Introduction to Philosophy
(Elective Course of Group A.1, 1st semester)

The historical, hermeneutical and systematic approaches in philosophy. Branches and periods of western philosophy. Systematic presentation and analysis of such central problems of philosophy as validity of knowledge, truth, causality, mind and matter, the external world, universal concepts, freedom of the will, language and reality, being and becoming. The importance of philosophy today.

B. Karasmanis

9.1.56.1 History of the Science and Technology
(Elective Course of Group A.1, 1st semester)

Characteristic features of the scientific phenomenon and of technological development and their interaction are considered, in a passage through history ranging from the 6th century B.C. to the scientific revolution of the 16th-17th centuries. The scientific ideal of each of the important periods (ancient Greece, Latin Middle Ages, modern times) and the particular relationship between science and technology for each period will be outlined.

P. Rapti

A.2
SAMPS/Humanities

9.1.35.8 Greek and International Mercantile Marine
(Elective Course of Group A.2, 8th Semester)

International trade and international maritime transport. Exports and imports of commodities and services and balance of payments. Elements of the theory of international trade. The role of currency exchanges. Phases of the economic cycle and their consequences on international trade. Modern tendencies of international trade and maritime transport. Sea-going cargoes. International commodity sea routes. International organizations and codes of safe transportation. International maritime transport as export and import of services. The nationality of the merchant ship and ships with flags of open registries. State maritime policy. Historical development and today's tendencies of international maritime trade. The Greek economy and mercantile marine. The development of international trade of the Greek economy (1960-1996). Brief review. The Greek and Greek-owned merchant fleet. The empirical viewpoint. Shipping foreign exchange and balance of current accounts. Tendencies of restructuring the world and Greek mercantile marine. The contribution of the mercantile marine to the Greek economy.

I. Milios, P.Michaelidis

9.1.24.8 Special Topics in Sociology
(Elective Course of Group A.2, 8th Semester)

The course addresses the process of industrialization and it's consequences, bureaucracy, professional development, roles at work, the functioning of the industrial unit in relation to the environment, the automated industrial unit, the structure and operation of trade unions, the development of an industrial to a post-industrial society.

The course focuses on the relations of gender and technology. Despite the fact that women are closely related with the reproduction technologies, they are frequently presented as technophobic, incompetent for technological design only suitable for technology use. This hypothesis is examined theoretically and historically. We investigate if and how the technology influences women differently from men, how women use it in different ways and how it determines the concept of gender. Students are encouraged to report their experiences as users, consumers and technology designers, on the internet, PCs and medical technologies. The course aims at the sensitization of students vis-a-vis the new reproduction, production genetics and informatics technologies.

M. Rententzi

9.1.34.8 History of Economic Theories
(Elective Course of Group A.2, 8th Semester)

Mercantilism and its decline. Mercantilist bibliography. The first English mercantilists. The flourishing of mercantilist theory. Reaction against mercantilism. The emergence of the theories of value and money. The physiocrats and the state of the economy in France during the mid-18th century. The social philosophy of the physiocrats, social classes, net product, the economic table of Quesnay, economic policy, the inheritance of the physiocrats. Adam Smith: industrial capitalism in England during the mid-18th century. The social philosophy of Adam Smith. Division of labor. The theory of value. The theory of distribution. The theory of capital and productive labor. David Ricardo: the industrial revolution in England. The philosophical and methodological foundations of Ricardo's theory. The theory of value. Wages and profit. The decline of the classical school, Malthus and the population law. Conflicts regarding Ricardo's theory of value. The theory of abstinence. Harmony of interests, Sismondi as a critic of capitalism. The utopian socialists. The twilight of the classical age. Karl Marx: abstract theory of labor and value, theory of modes of production. The neo-classical school. Marginal benefit and equilibrium of demand and supply, the production function.

I. Milios, P. Michaelidis

9.1.46.8 Cognitive Theory in Modern and Contemporary Philosophy (Elective Course of Group A.2, 8th Semester)

Introduction to modern philosophy, rationalism, empiricism. Kant's critical standpoint. Scepticism, the emergence of the general question of philosophical method. The post-Kantian attempt at constructing pure reason by Frege and Russell. Critique of the limits and possibilities of success of such an effort by Wittgenstein.

A. Koutoungos, St.Gerasimou

9.1.47.8 Introduction to Philosophy of Science (Elective Course of Group A.2, 8th Semester)

What is epistemology. The problem of induction in Hume. Differences in propositions (analytic, synthetic, a priori, a posteriori) in Kant. Classification of sciences into natural and social. Science and technology. Logical positivism. Popper and verifiability. Kuhn: "normal" and "revolutionary" science. Lakatos and "scientific research programmes". Feyerabend and the "anarchist" methodology. Analytic philosophy and theories of meaning. French epistemology, Bachelard, Althusser and followers. Recent approaches.

V. Karasmanis, K. Theologou

9.1.57.8 Introduction to the History of Engineers (Elective Course A.2, 8th Semester)

This course will refer to the history of engineers, considering that their activity is intertwined with the societies, where they have acted. In the historical course from the Egyptians until the contemporary engineers, emphasizing on the engineers acting in the Greek state, the continuity points which shape the sector will be traced. Also the discontinuity sectors which are related with the integration of the core activities of engineers with the innovations of the nation. The renaissance and industrial phenomena as nodal points of the development of engineers will be highlighted. There will be a reference to the aspects of the activities that are beyond scientific logic, the difficulties in achieving targets, the endogenous heterogeneity of the activity of engineers which has special importance in our country, the relations of engineers with technicians and workers regarding the produced result, the relations of military engineers and politicians, but also to the marine engineers because of the School. The course includes the history of Greek engineers and NTUA since 1837 and TEE since 1923, based on the recent research.

M. Asimakopoulos

SAMPS/Mathematics

9.2.52.8 Numerical Analysis II
(Elective Course of Group A.2, 8th Semester)

Introduction to the numerical solution of Sturm-Liouville and Dirichlet problems using the finite element method - Loaded string and loaded membrane. Introduction to Hilbert and Sobolev spaces, Weak form, Lax-Milgram theorem, general Galerkin method, variational form. Elliptic boundary value problems. Quasi-harmonic equation. Finite element methods. Piecewise linear and quadratic functions, Hermite and spline functions, product functions. Error estimates. Heat and fluid flow. Loaded beam and plate. Parabolic and hyperbolic boundary value problems. θ-methods. Diffusion equation. Wave equation. Nonlinear heat equations. Navier-Stokes equations.

V. Kokkinis,
E.Tichopoulos

SAMPS/Mechanics

9.3.07.8 Elasticity Theory
(Elective Course of Group A.2, 8th Semester)

Elements of Tensor Calculus and Calculus of Variations. Attractor and tensor voltage. Equations of Equilibrium. Tees and speed. Compatibility equations. Constitutive equations of elastic material. Equations of Elastostatic field. Boundary Value Problem. Energy Theorems. Two-dimensional and three-dimensional elastostatic problems.

Ch.GeorgiadiD

9.3.09.8 Disks-Plates-Shells
(Elective Course of Group A.2, 8th Semester)

Tensor analysis in curvilinear co-ordinates. Disks: stress functions, boundary conditions, solution techniques, polar co-ordinates, applications. Plates: assumptions of thin plate theory, plate equations (in cartesian and polar co-ordinates), applications. Shells: membrane theory, axisymmetric shells, bending of shells, applications.

E. Theotokoglou

Courses from Schools other than Mechanical Engineering (SME)

5.1.30.8 General Chemistry
(Elective Course of Group A.2, 8th Semester)

Atomic theory. Chemical bonds. Solid state chemistry. Electrolytic solutions. Elements of electrochemistry. Chemistry of organic coatings. Polymers. Photo-chemistry and photo-electrochemistry. Nuclear chemistry and technology. Chemistry of water and potable water. Techniques of desalination and water softening. Water pollution. Restoration of environment following pollution accidents. Chemistry of the atmosphere. Atmospheric pollution.

K. Kollia

3.2.42.8 Data Processing
(Elective Course of Group A.2, 8th Semester)

Introduction to programming using PASCAL. Structured programming

G. Kambourakis

3.3.43.8 Electronics
(Elective Course of Group A.2, 8th Semester)

Insulators, semiconductors and metals. Diode characteristics and applications. Photodiodes, light-emitting diodes, the photovoltaic phenomenon, solar accumulators. Diode circuits, rectifiers. Transistors and their applications. The transistor as an amplifier and as a receiver. Digital circuits, logical gates. Amplifiers and their applications.

E. Kagiafas

A.3
SAMPS / DHSSL

9.1.11.9 Elements of Law and Maritime Law
(Elective Course of Group A.3, 9th Semester)

General aspects of law. Administrative law, Private law (general principles, law of obligations, property law, expropriation). Commercial law, community labour law, labour accidents and liability of the engineer. European law. Elements of maritime law (ship, ownership, maritime credit, maritime privilege, ship collisions).

A.Koutougkos, St. Gerasimou

SAMPS / Mechanics

9.3.06.9 Fracture Mechanics
(Elective Course of Group A.3, 9th Semester)

Types and mechanisms of fracture. Elements of linear elasticity (complex potentials, conformal mapping, Westergaard functions). The stress field at a crack tip (stress intensity factors and crack types. Fracture criteria. Experimental determination of *K*). The plastic region in way of a crack tip. Griffiths' classical energy theory. Theoretical fracture strength. Elasto-plastic fracture. *R*-curve. Rice's *J*-integral. Crack opening displacement (*COD*) theory. Crack initiation criteria under combined loading conditions. Dynamic crack propagation. Fatigue. Paris' criterion.

G.Papadopoulos

9.3.08.9 Numerical Methods with Engineering Applications I
(Elective Course of Group A.3, 9th Semester)

Introduction to the finite element method. General description of the method and related observations. Convergence criteria. Prismatic sections (rod element, beam element). Plane elasticity (triangular and rectangular element). Three-dimensional elasticity. Axisymmetric bodies. Higher order elements. Isoparametric elements. Plates and shells.

E. Theotokoglou

9.3.10.9 Analytical Mechanics
(Elective Course of Group A.3, 9th Semester)

Lagrangian mechanics: bonds and forcing conditions. D' Alembert's principle. Lagrange equations of the 2nd kind, with and without friction. Circular co-ordinates and conservation laws. Lagrange equations of the 1st kind. Hamilton's principle. Applications of mechanics: Central motion. Accelerating co-ordinate systems. The solid body. Hamiltonian mechanics. Hamilton equations. Poisson brackets. Normal transformations. Normal invariants. Liouville's law. Symmetries and conservation laws. Hamilton-Jacobi theory.

I. Kominis

SAMPS / Physics

9.4.84.9 Physics III (Wave Mechanics)
(Elective Course of Group A.3, 9th Semester)

Simple harmonic motion. Damped vibrations. Forced vibrations. Coupled vibrations. Vibrations of systems with one, two or N degrees of freedom. The wave equation. Transverse and longitudinal waves (acoustic waves in gases, transverse waves in a string, longitudinal waves in solids, water waves). Traveling and stationary waves. Fourier methods. Wave transmission. Reflection, refraction, polarization, convergence and diffraction. Applications to mechanical systems. Sound. Acoustics. Laws of optics. Optical instruments. Lasers. Measurements with optical instruments.

I. Raptis

Courses from Schools other than Mechanical Engineering (SME)

5.3.23.9 Corrosion of Materials and Criteria for Selection for Marine and Mechanical Applications
(Elective Course of Group A.3, 9th Semester)

Selection and use of materials and equipment and methods of protection. Relationship between structure and behavior. Atmospheric corrosion and wear of materials, metals and coatings. Protection and types of protection. Cathodic protection of structures and offshore structures. Protection of hull structures. Problems arising from poor geometry, incompatibility, and/or poor selection of materials. Failure analysis/case studies.

P. Vassiliou

5.4.08.9 Fuel and Lubricant Technology
(Elective Course of Group A.3, 9th Semester)

Energy Balances. Ranking of Fuel. Crude Oil: Research, Production, Properties. Processing Petroleum refinery processes. Gasoline: Production, Properties, Environmental Impacts. Diesel: Production, Properties, Environmental Impacts. Fuel Oil: Production, Properties, Uses, Environmental Impacts. Marine Fuels: Production, Properties, Environmental Impacts, Problems Use. Lubricants: Production, Properties, Classification, Uses. Solid Fuels. Fuel Gas.

F. Zannikos, D. Karonis

1.21 Description of Group B Courses

School of Mechanical Engineering (SME)

2.5.04.8 Hydrodynamic Machines I
(Elective Course of Group B, 8th Semester)

Natural energy sources. Turbomachinery (torque development, velocity triangle). Fundamental equations. Types and operation of turbomachinery. The centrifugal pump. Water turbines.

D. Papandonis

2.1.07.8 Operations Research I
(Elective Course of Group B, 8th Semester)

Subject and methodology. Allocation problems. Linear programming. Non-linear programming. Investment analysis.

N. Kirittopoulos, S. Ponis

2.1.12.8 Programming and Control of Production I
(Elective Course of Group B, 8th Semester)

Factory layout. Planning of project execution. Network programming, CPM and PERT methods. Gantt charts. Project cost and cash flow. Project control and monitoring. Computer-based project planning and monitoring.

V. Leopoulos

2.2.11.8 Refrigeration I
(Elective Course of Group B, 8th Semester)

Elementary refrigeration cycle using mechanical steam compression. Refrigeration cycle of mechanical steam compression, with overcooling of condensate and suction of superheated steam. Refrigeration cycle of multistage mechanical steam compression. Means of refrigeration. Measurement of refrigeration power. Stirling cycle. Elementary air liquefaction cycle. Low high pressure air liquefaction cycle. Air liquefaction with partial xxx. Minimum work for liquefaction of gases. Compression using fluid bands. Vortex tube. Thermoelectric refrigeration. Refrigeration with demagnification. Refrigeration with suction. Refrigeration installations using NH3/H2O and H2O/LiBr. Refrigeration systems based on adsorption and re-adsorption. Psychrometry. Sensible air refrigeration and heating. Refrigeration and dehumidification. Adiabatic mixing.

X. Tzivanidis

2.3.20.8 Conveyors and Lifting Machinery
(Elective Course of Group B, 8th Semester)

Introduction. The general conveying problem. Properties of materials. Steel structures for conveyors and lifting machinery. Loads, failures calculation techniques. Conveyor belts. Belt elevators. Chain conveyors and lifting machinery. Screw conveyors. Vibrating feeders. Low pressure air conveyors. Dust collectors. Winches. Skip hoists. Cranes.

I. Antoniadis, V. Spitas

2.3.05.8 Machine Elements II
(Elective Course of Group B, 8th Semester)

Gears and reduction gearing. Motion transmission and power transmission using toothed wheels. Cylindrical, spur and helical gears. Tooth compliance, load distribution and optimum conjugate gears. Types and causes of gear failures. Tooth flank modifications. Bevel, helical and worm gears. Epicyclic and planetary gear trains. Rolling and journal bearings. Seals and lubrication. Clutches. Gearbox rating and characteristics. Gear measurements. Applications of gear design and power transmission in mechanical drives.

Laboratory exercises: Use of photoelasticity in examining stresses in a wheel. Measurement of errors in geared wheels. Wear, lubrication, maintenance and industrial software in components and means of transmission of motion using geared wheels.

Th. Kostopoulos

2.3.04.9 Machine Elements I
(Elective Course of Group B, 9th Semester)

Springs. Axles. Shafts. Bearings. Belt drives.

V.Spitas

2.1.02.9 Production Management and Business Administration
(Elective Course of Group B, 9th Semester)

Introduction. The enterprise and its operation. Production management. Product design. Planning and control of production. Production cost accounting. Quality control. Work study. Maintenance of installations. Factory organization.

H. Tatsiopoulos, N. Marmaras

2.2.07.9 Steam Generators I (Elective Course of Group B, 9th Semester)

Steam production. Development of steam boiler technology. Steam boiler characteristics. Classification of contemporary steam generators. Natural and forced circulation. General principles. Heat transfer. Energy transmission. Efficiency. Fuels, combustion chamber.

E. Kakaras, S.Karellas

2.2.08.9 Heat Transfer II
(Elective Course of Group B, 9th Semester)

Thermal boundary layer theory. Advanced radiation issues. Mathematical theory of combustion. Heat transfer in two phase systems.

M. Founti, D. Hountalas

2.5.06.9 Thermal Turbomachines
(Elective Course of Group B, 9th Semester)

Introduction to the morphology, operation and aerothermal analysis of thermal turbomachines. Types of thermal turbomachines, compressor, turbine, steam-turbine. Fundamental governing equations. One-dimensional flow in thermal turbomachines. Flow analysis in two-dimensional cascades. One-dimensional flow analysis in axial and radial compressors. One-dimensional flow analysis in axial and radial turbines. Single- and multi-stage turbomachines.Turbine and compressor similarity. Basic mechanical features.

Experiment in the Lab: Experimental determination of a compressor characteristic curve. Homework on turbomachinery computations.

K. C. Giannakoglou

2.1.14.9 Operations Research Laboratory
(Elective Course of Group B, 9th Semester)

Computer-aided laboratory exercises (case studies) on the following topics: Spreadsheets, linear programming, non-linear programming, integer programming, modelling, heuristics, expert systems, decision support systems, decision analysis, analysis of product distribution networks.

N. Panagiotou

2.1.16.9 Programming and Control of Production II
(Elective Course of Group B, 9th Semester)

The nature of production-inventory systems. Overview of production systems. Demand forecasting. Aggregate production planning and Master Production Scheduling (MPS). Inventory management.

H. Tatsiopoulos

2.5.05.9 Industrial Fluid Mechanics
(Elective Course of Group B, 9th Semester)

One-dimensional flow of compressible fluids. Fanno and Rayleigh curves. Isothermal flow. Perpendicular impact waves. Converging-diverging nozzle. Flow in channels. Industrial systems: hydraulic, natural gas, ventilation. Steady dynamic flow about a two-dimensional wing section. Theory of thin sections (sources, vortices). Boundary element method in two-dimensional problems. Low speed aerodynamics: buildings, bridges, airports, vehicles. Wind tunnels. Ventilation of motorway tunnels.

D. Mathioulakis, S. Voutsinas

2.2.17.9 Refrigeration and Laboratory
(Elective Course of Group B, 9th Semester)

Elementary refrigeration cycle using mechanical steam compression. Refrigeration cycle of mechanical steam compression, with overcooling of condensate and suction of superheated steam. Refrigeration cycle of multistage mechanical steam compression. Means of refrigeration. Measurement of refrigeration power. Stirling cycle. Elementary air liquefaction cycle. Low high pressure air liquefaction cycle. Air liquefaction with partial xxx. Minimum work for liquefaction of gases. Compression using fluid bands. Vortex tube. Thermoelectric refrigeration. Refrigeration with demagnification. Refrigeration with suction. Refrigeration installations using NH3/H2O and H2O/LiBr. Refrigeration systems based on adsorption and re-adsorption. Psychrometry. Sensible air refrigeration and heating. Refrigeration and dehumidification. Adiabatic mixing. Semester project and Laboratory.

X. Tzivanidis

1.22 Description of Group C Courses

School of Naval Architecture and Marine Engineering (SNAME)

8.2.36.8 Applied Functional Analysis with applications in engineering problems (Elective Course of Group C, 8th Semester)

The importance of functional analysis in engineering problems. Generalization of the concepts of distance and convergence. Metric spaces, completeness, xxx. Examples. Steady point theorem and applications to the solution of functional (differential, integral) equations. Linearity. Hilbert and Banach spaces. Concept and importance of base. Fundamental theorems. Operators in Hilbert and Banach spaces. Compact and self-adjoint operators. Spectral analysis of operators. Application to Sturm-Liouville problems. Expansions as eigenfunctions. Examples. Special bases in functional spaces. Non-orthogonal bases in free-surface problems. Expansions as wavelets. Differential calculus in Banach spaces (Volterra, Gateaux and Frêchet differentiation). Differentiation of non-linear functionals and operators. Applications to the calculus of variations. Construction of variational principles for physical problems. Mathematical foundations of the finite element method.

G. Athanassoulis, S. Argyros

0.9.01.8 Environment and Development (Elective Course Group C 8th semester)

Interdisciplinary course dealing with environmental problems arising from engineering activities.

A. Papagiannis
School representative: G. Triantafyllou

8.9.03.8 Introduction to Non-linear Systems with Applications in Naval Architecture (Elective Course of Group C, 9th Semester)

Transition from the simplicity of a linear to the complexity of a non-linear system. Steady and transient behaviour, analysis in phase space, stationary points and periodic orbits, co-existence of multiple solutions, stability. Attractors and basins of attraction. Flows in phase space. Examples and analogies with the physical world. Numerical solution of stationary points and stability assessment. Poincaré maps, Floquet's theory. Analytical methods based on perturbation theory, their usefulness and their limitations in highly non-linear systems. Evolution of a dynamic system resulting from parameter changes. Local bifurcations and qualitative description of elementary types of bifurcations. Applications to ship motions, structures and marine engines. Co-dimensions and structural stability of a

system. Global bifurcations and their importance in the safety of mechanical systems. Reduction of complex systems to simpler forms. The concept of chaos in non-linear dynamics and simple examples. Strange attractors, sensitivity to initial conditions and loss of predictability. Transition to chaotic behavior. Fractal dimensions and self-similarity.

The course includes the preparation of an elective project with the appropriate computing equipment.

K. Spyrou, I. Georgiou

8.9.45.8 Practical Training
(Elective Course of Group C, 8th and 9th Semester)

Practical training of students with own work for a period of at least six (6) weeks in a major shipyard or on board a ship at sea.

G. Zarafonitis and other faculty members

8.2.38.9 Wavelets. Time-frequency domain analysis and applications
(Elective Course of Group C, 9th Semester)

Normal spaces, Banach spaces and basic theorems. Fixed point theorem. Hilbert spaces and examples, Optimal approximation, Projection theorem. Riesz theorem. Orthocanonical bases. Hilbert subgroup space criterion. Legendre polyonyms, Hermite polyonyms and Laguerre polyonyms , trigonometric system, Rademacher, Walsh and Haar Orthocanonical systems. Normal operators and spaces. Fundamental theorems and compact operators adjoint operators. Spectral analysis of operators. Eigenfunctions, non orthogonal bases and applications in free surface problems. Biorthogonal systems. Frame theory, dual frames and inversion.

Gabor transformation Inversion theorem. Gabor frames & applications. Haar, Meyer, Mexican hat, Morlet wavelet examples. Rectangular and non rectangualar wavelets, smoothness and fitness. wavelet frames. Discrete wavelet transformation. multiresolution analysis. FWT, Mallat algorithm. Differentiation and wavelets. Polyonym non linearity of wavelets. Applications in signal processing. Wave analysis of wave formations. Galerkin solutions of differential equations. Use of wavelet-Galerkin bases, Gabor-Galerkin and their comparison.

MATLAB exercise.

G. Athanassoulis

8.9.91.9 Ship Design Project I, II, III, IV
(Elective Course of Group C, 9th Semester)

Students who require a pass from previous semesters in this course are requested to enroll in Ship Design Project II, III, IV.

A. Papanikolaou and other NAME staff members

1.23 The Ship Design Project

The mandatory course Ship Design Project I is included in the 7th Semester. The elective courses Ship Design Project IIa and Ship Design Project IIb are included in corresponding streams during the 8th semester. The purpose of the project is to give students the opportunity to apply the material taught in the Naval Architecture and Marine Engineering courses. At the same time this work aims at developing the necessary critical faculties and professional preparation of graduate naval architects and marine engineers.

The work covers a full preliminary design study of a selected vessel on the basis of specified owners' requirements and national/international regulations of safety and construction. The project work includes all calculations and drawings at the standard expected by classification societies or other authorities or for the signing of a contract between owner and shipyard. The various stages of the work are outlined below:

- Estimation of main dimensions and weights. Stability calculations, construction plans, outfitting, general arrangement.
- Global and local strength calculations. Resistance and propulsion estimates, selection of main propulsive machinery. Maneuvering and sea-keeping qualities.
- Mechanical and electrical installations, main propulsion plant, auxiliary machinery, piping systems.
- Construction specification, shipbuilding contract.

When necessary, calculations are carried out using computer programs and databases which are made available to students (Ship Design Laboratory). A number of the drawings required are also prepared in the Ship Design Laboratory. The work is evaluated by faculty staff and is co-ordinated by a faculty member of the Department of Ship Design and Maritime Transport.