General information	
Academic subject	***MATHS***
Degree course	Nautical Science and Maritime Management
Academic Year	*I*
European Credit Transfer and Accumulation System (ECTS)	12
Language	*Italian*
Academic calendar (starting and ending date)	*I year – I semester*
Attendance	*No, but attendance is strongly recommended*

Professor/ Lecturer	
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Tutoring (time and day)	

Syllabus	
Learning Objectives	*To provide students with a good foundation of theoretical, methodological and applicative skills in the fundamental areas of the discipline. Skills of analysis and synthesis, individual learning, problem solving, understanding and use of mathematical models of both scientific and applied interest will be developed.*
Course prerequisites	*Basic content of mathematical analysis.*
Contents	*1) Scalar functions of several variables, natural domain, graph. Vector space . Surrounding of a point of , isolated point and accumulation point. Notion of definitively verified properties. Local extreme points.*

	2) Limits and continuity for functions of several variables. Open, closed, finite sets. Concepts of interior point, open set, exterior point, closed set. Frontier points, limited sets. *3) Directional and partial derivatives, gradient. Notion of critical point, Fermat's theorem. Differentiability, best linear approximation. Regularity of differentiable functions, total differential theorem.* *4) Subsequent derivatives, Schwarz theorem, Hessian matrix. Taylor polynomial for functions of several variables. Free extremes of functions with scalar values.* *5) Sign of real symmetric matrices, study of the nature of critical points.* *6) Introduction to Optimisation Problems. Examples: resource planning problems, scheduling problems. Examples of non-linear problems. The modelling approach to optimisation problems. Deterministic and stochastic models. Continuous, discrete and mixed optimisation problems.* *7) Definition examples of mathematical scheduling models. Linear programming. Classical examples of linear programming problems: the diet problem. Standard form problems. Admissible region. Convex sets. Admissible solutions and optimal solution. The case of an unlimited admissible region. Multiple solutions. The graphical method for linear programming problems in two dimensions. Linear programming problems in standard form. Slack variables.* *8) The augmented problem. The simpllex method. Table structure of the simpllex method. The case of unlimited functions. The case of multiple solutions. Degenerate solutions. Anti-cycle rules: Bland's rule. Problems in non-standard form. Minimisation of linear functions. The case of decision variables with negative values. Constrained decision variables. Equality constraints. Major-equal constraints. Artificial variables and surplus variables. Definition of the artificial problem. The two-stage simplex method. Post-optimal analysis. Shadow prices.* *9) The transport problem: the mathematical model. Eligibility condition for the transport problem. The initial BFS problem. The Northwest Rule. Vogel's method. Russell's method. The case of degenerate BFS. The simpllex method for the transport problem. Integer property of solutions. The transport problem with a fictitious source or destination. The case of indefinite costs.* *10) Binary linear programming problems. The knapsack problem. The assignment problem. The Hungarian method for the assignment problem.* *11) Optimisation problems on networks. Definition of oriented and undirected graph. Properties and terminology of graphs. The minimum covering tree problem. Prim's algorithm. Kruskal's algorithm. The Reverse-Delete method. Decreasing sides. Optimality condition for a covering tree. The minimum path problem. Dijkstra's algorithm. Lattice techniques for project management. PERT and CPM. AON and AOA techniques. Definition of critical path. Gantt diagrams. Crash of an activity. Time-cost trade-offs.* *12) Binary and integer linear programming problems. The Branch-and-Bound method for binary problems. Definition of subproblems. Impending solution. Fathoming criteria. Optimality testing. The Branch-and-Bound method for*

	integer and mixed problems. Fathoming criteria for integer programming problems.
Books and bibliography	1) *Bertsch, Dell'Aglio, Giacomelli – Epsilon 1 Primo corso di Analisi Matematica - Mc Graw Hill* 2) *F. Hillier, G. Lieberman, Ricerca Operativa, McGraw-Hill* 3) *Any operational research exercise text*
Additional materials	

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
300	*96*		*204*
CTS			
12	*8*		*4*

Teaching strategy	*Lectures in which the subject content is explained, with theorem demonstrations and examples. An important part is the presentation of the resolution of selected exercises in order to exemplify the theory and provide the basis for practical applications.*
Expected learning outcomes	
Knowledge and understanding on:	o Knowledge of the definitions and theorems in the programme o Knowledge of methods for solving exercises. o Understanding of content and ability to carry out demonstrations independently. o Ability to solve problems using the course content
Applying knowledge and understanding on:	o Understanding of mathematical modelling methods in various fields o Ability to solve application problems related to the course content. o Ability to analyse the results obtained
Soft skills	• Autonomy of judgement At the end of the course the student should be able to o Explain the content covered in the course, demonstrating an understanding of its logical approach and aims. o Demonstrate knowledge of solution methods for solving applied problems o Be able to model a problem using the most appropriate methods, be able to execute the relevant solution algorithms and interpret the results. • Communication skills o Be able to explain the approach to solving a problem in a clear and rigorous manner. o Be able to justify the choice of procedure adopted in solving a problem. • Ability to learn autonomously o Be able to research, understand and apply new content and methods.

Assessment and feedback	

Methods of assessment	*Written test with possible oral test*
Evaluation criteria	• Knowledge and understanding ○ Conscious knowledge of the definitions, theorems and proofs provided by the program. • Applying knowledge and understanding ○ Understanding of mathematical modelling methods, ability to use them independently in problem solving. • Autonomy of judgment o Ability to expound, both written and oral, the course content by demonstrating that they have acquired it consciously. • Communication skills ○ Knowing how to clearly and rigorously explain the theoretical contents and approaches adopted in solving a problem. • Capacities to continue learning ○ Evidence of active understanding the disciplinary contents, ability to accurately identify appropriate solution approaches.
Criteria for assessment and attribution of the final mark	

Grade	***Descriptor***
< 18 *insufficient*	*Fragmented and superficial knowledge of the contents, errors in applying the theoretical results in solving exercises, lack of exposure.*
18 - 20	*Knowledge of the contents just sufficient but general, simple exposition, uncertainties in the application of the theory in solving the exercises.*
21 - 23	*Appropriate but not in-depth knowledge of contents, ability to apply theoretical concepts, ability to present contents in a simple way.*
24 - 25	*Knowledge of content appropriate and extensive, discreet ability to apply knowledge in exercise resolution, ability to present contents in an articulated way.*
26 - 27	*Precise and complete knowledge of contents, good ability toa pply knowledge, analytical skills, clear and correct presentation.*
28 - 29	*Wide, complete and in-depth knowledge of contents, good application of contents, good ability to analyze and synthesize, safe and correct exposure*
30 *30 with lode*	*Very broad, complete and in-depth knowledge of the contents, well-established ability to solve problems using the results of* *The theory, excellent analysis and synthesis skills, mastery of exposure*

Additional information	