Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Operations Research
Course code	42150
Scientific sector	MAT/09
Degree	Bachelor in Industrial and Mechanical Engineering
Semester	II
Year	II
Academic Year	2018-2019
Credits	6
Modular	No

Total lecturing hours	36
Total lab hours	6
Total exercise hours	24
Attendance	Highly recommended
Prerequisites	Linear algebra and differential calculus
Course page	

Specific educational objectives	The course covers the main decision making techniques such as linear programming and integer programming, optimization on graphs, project management models and how to model specific problems in the engineering field. Furthermore, specific algorithmic techniques are shown during the course to support the modelling part and solve real-world problems. The goal of the course is to provide the ability to develop appropriate models for each application, to find their optimal solution and to implement the appropriate algorithm to practically solve them. How to interpret the obtained results will be also a core topic of the course.

Lecturer	Valentina Morandi
Scientific sector of the lecturer	MAT/09
Teaching language	English
Office hours	18
Teaching assistant (if any)	-
Office hours	By appointment from Tuesday to Thursday
List of topics covered	**Introduction to Operations research:** History of OR – How to define a problem - Variables, constraints and objectives – Revision of correlated topics in Linear Algebra.

Linear programming:

Introduction and definition of linear programming (LP) models – Graphical solution on an LP model – The simplex method – Dual formulation – Primal-Dual relationship – Sensitivity analysis – Shadow prices.

Integer linear programming:

Introduction to Integer Linear Programming (MILP) and Mixed Integer Linear Programming (MILP) – ILP based problems (0-1 knapsack, assignment location problem and TSP) – Solving challenges: polynomial vs non polynomial algorithms – Cutting planes algorithm – Branch and Bound algorithm – Tree exploration strategies.

Heuristics:

Introduction to simple heuristic algorithms – Study case: The TSP and its heuristics.

Graph theory:

Networks and graphs notation – Minimum spanning Tree (Prim and Kruskal algorithm) – Shortest path (Dijkstra algorithm) – Max flow problem – Max flow Min cut theorem - Hints on transportation problems.

OR in logistic:

The VRP problem – The Facility location problem – The Two Echelon supply chain optimization – The inventory routing problem – Hints on production models.

Project management:

Schedule activities as a project manager using the PERT/CPM model – Dealing with uncertainty in project management.

Non-linear optimization:

Hints on non-linear optimization –The product mix and the minimum shipping cost with volume discount problem.

Computer lab:

Mathematical Programming Language (MPL) – Interaction with Excel and databases – Gmaps API – Other specific solvers.

Teaching format	Theoretical, Exercise and Computer lab lectures.

Learning outcomes (ILOs)	The learning outcomes need to refer to the Dublin Descriptors: Knowledge and understanding 1. Knowledge of Linear and Non Linear Programming optimization techniques. Understanding the basics of graph theory and applications. Applying knowledge and understanding 2. Application of various optimization techniques to real problems. Though the focus will be on logistic and industry-related problems, other real problems will be tackled in order to provide a complete overview of what can be done using OR techniques. Making judgements 3. Making judgement on the correctness of the adopted model, on the coherence of obtained outputs and on the sensitivity analysis applied to a specific problem. Communication skills 4. Explain the results obtained from a mathematical model, emphasize the critical aspects and the potentiality of each proposed model. Ability to learn 5. Ability to transfer the main OR techniques, learnt during the course, in professional experience. In particular, the student will be able to provide a model and a solution method for several problems that could occur in a production, logistic and mixed context.

Assessment	**Formative assessment** The assessment will go through three different parts: the Written exam, the Oral exam and the Lab project. In particular, the Written exam and the Lab project will be discussed during the Oral exam.

Form	%	Length /duration	ILOs assessed
Written exam	70	2 hours	**1,2,3,4**

Lab project	10	At home	2,3,5
Oral exam	20	-	1,2,3,4,5

During the course, it will be asked to provide notes of the previous lecture following a round-robin scheme (one student at a time). The lecturer will correct and expand these notes, if needed. No evaluation will be given on the notes. It will be only a further tool for you to study and to keep track of your progress during the course.

Assessment language	English
Evaluation criteria and criteria for awarding marks	- Knowledge of theoretical basis of OR and, in particular, Linear and Integer programming. - Ability of applying solution techniques to real problems. - Use of specific software to solve models. - Ability to perform a critical analysis on the outputs.

Required readings	Hillier, Lieberman, Introduction to Operations Research, McGrawHill
Supplementary readings	Several exercise books are available in the University Library. No preferences among these books.