Ben-Gurion Universty of the Negev
Beer-Sheva

Blaustein Institutes for Desert
Research

Elective Class

Advanced Management and Optimization of Water Systems and WasteWater Reclamation

ניהול מתקדם ואופטימיזציה של מערכות מים והשבת שפכים

Number of Course - 001.2.5077; Autumn Semester, 2025

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Background

The graduate course is dealing with topics related to management aspects application of natural resources, water and agricultural systems and sustainable development applying non-linear optimization (adapted from Operations Research methods). The models towards optimal design and operation of systems will be defined and solved. Prior to this phase a background in optimization will be presented, subject to the linearity and non-linearity of the problems tackled. The complementary part will include directions to conduct sensitivity analysis.

All the topics listed in the syllabus will be followed under two essential stages: (i) theoretical background related to the topic listed, and; (ii) a simple example related to the topic and the related characteristics. The examples will cover specific cases and can be applied to any other comparable topics.

Transshipment will refer to traveling of any kind in short and long routs. The emphasizes will be on using short and relatively slow traveling routs and the long and quick routes. It refers also to aspects of removing resources from one source to another one.

Integer programming refers to variables that get only integer values suck as 1, 2, 3,…. which requires special treatment. Continuous values such as 2.28 (only an example) cannot be accepted.

Fixed charge issues can be identified in economic enterprises in which part of the input data includes fixed data. The problems need special treatment. Problems of similar type can be found in numerous practical and scientific problems.

LaGrange and Gradient methods refer to non-linear programing. Most of the optimization problems worldwide are non-linear. Linear programing is the simplest

optimization - however, the non-linear problems faces the user with issue related to evaluating the real optimal point. The example will include aspects related to disposal and reuse of the brine of desalination plants.

Goal Programming (GP) is a kind of introduction to cases in which one faces problems with several objective functions (commonly cost functions). Actually it involves a kind of equilibrium between targets and the judgment of the decision makers what he is ready to give up and what is the main goal. An example will include a problem of fertilizers application in an agricultural area.

Analytic Hierarch Process (AHP) is a method that allows us to select to preferable alternatives among several possibilities. It is based on methods developed by Saaty and was applied to a series cases. The example of the options of solving the sinkhole in the Dead Sea and the filling of the Kinneret (Sea of Galilee).

The Purpose of the course

The purpose of the course is to provide the participants with a broad view and applicable tools allowing them to analyze natural resources systems towards their optimal utilization, subject to environmental, economic, health, social, traditional and other related constraints. The tools for implementation will be based on application of non-linear programming taken from Operations Research methodology.

The course structure

The graduate course is based on weekly meeting of two hours each. Homeworks will be assigned as part of the training. Around five home assignments will be submitted. At the end of each semester a final term examination will be given, or alternatively a final project on a selected topic.

Prerequisites

The participating students should have some background in engineering computations, statistics, linear algebra and economics (pre-request: **001-2-5071**).

Tasks

The course is based on 5 home assignments and final homework. The Credits are:

Home assignments - 60%

Semester final assignment - 40%

Participation in class

Each participant has to take part in 85% of the lectures

Table 1. Course outline

Meeting	Topic
Week 1	Duality and Sensitivity Analysis
Week 2	Transshipment
Week 3	Integer Programming
Week 4	Integer Programming
Week 5	Fixed Charge
Week 6	LaGrange multipliers
Week 7	The Gradient
Week 8	The Gradient
Week 9	Goal Programming
Week 10	Goal Programming
Week 11	AHP (Alternative comparison)
Week 12	AHP (Alternative comparison)
Week 13	Complementary topics

Primary literature

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