**EASTERN MEDITERRANEAN UNIVERSITY**

**DEPARTMENT OF INDUSTRIAL ENGINEERING**

**IENG518 Non-linear Optimization**

**Course Outline**

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| **COURSE CODE** | IENG518 | **SEMESTER / ACADEMIC YEAR** | | Fall 2023-24 | |
| **COURSE TITLE** | Non-linear Optimization | | | | |
| **CREDIT VALUE** | (3, 0, 0) 3 | | | | |
| **LECTURER(S)** | Assoc. Prof. Dr. Sahand DANESHVAR | | [sahand.daneshvar@emu.edu.tr](mailto:sahand.daneshvar@emu.edu.tr) | IE-C109 | +90 392 630 2773 |
| **COURSE TYPE** | Elective | | | | |
| **PRE-REQUISITE(S)** | Consent of the instructor | | | | |
| **DURATION OFCOURSE** | 14 Weeks | | | | |
| **COURSE SCHEDULE** | Monday 13:30-15:20 IE-E201 | | | | |
| **COURSE WEB LINK** | https://staff.emu.edu.tr/sahanddaneshvar | | | | |
| **COURSE DESCRIPTION**  Local and global optima. Newton-type, quasi-Newton, and conjugate gradient methods for unconstrained optimization. Kuhn-Tucker theory and Lagrangean duality. Algorithms for linearly constrained optimization, including steepest ascent and reduced gradient methods with applications to linear and quadratic programming. Interior point methods. Non-linearly constrained optimization including penalty and barrier function methods, reduced and projected gradient methods, Lagrangean methods. Computer implementation. | | | | | |
| **AIMS & OBJECTIVES**  The main aim of this course is to provide students with the necessary knowledge of nonlinear programming:   * Basics of convex analysis, * Optimality conditions, * Duality, * Unconstrained and constrained optimization. | | | | | |
| **GENERAL LEARNING OUTCOMES (COMPETENCES)**  On successful completion of this course, all students will have developed **knowledge** and **understanding** of:   * Usage of optimality conditions, * Algorithms of nonlinear programming. * Duality in nonlinear programming.   On successful completion of this course, all students will have developed **their skills in**:   * Carry out calculation in nonlinear programming, * Application of nonlinear programming.   On successful completion of this course, all students will have developed their appreciation of and respect for **values and attitudes** regarding the issues of:   * Nonlinear analysis. * Proving theorems in higher mathematics. | | | | | |
| **GRADING CRITERIA**  **Exams:** All examinations and assignments will be based on the lectures and tutorials. Assignments will be to hone the problem skills of the students. Students will be encouraged to go through their answer scripts and clarify their omissions and mistakes, if any. Descriptions of the examinations are as follows:  *Midterm Exam:* There will be one such examination covering all the teaching material up to the 7th week. This exam held on 20 November *2023(13:30-15:20)* which is not flexible.  *Final Exam:* The final examination will cover all the material studied throughout the semester, and has the same structure as the midterm examination. It will also be used to determine letter grades. Final exam held on 15 December *2023 (13:30-15:20)*.  *Quizzes:* There will be two quizzes that will held on  *30* October *2023 (15:30-16:20)* and 18 December *2023(15:30-16:20)*, respectively which are not flexible.  *Assignments:* Six homeworks in the form of assignments will be given to assess students’ problem solving ability. The dead line for submission each of them is **one week** after it is presented on course web link. Late submissions will not be valued.  Note: The voluntary paper presentation has (5%) bonus. Topics will be given by the instructor. | | | | | |
| **LEARNING / TEACHING METHOD**  Teaching will enable the students to understand the application of various statistical processes control methods. The function of teaching is to enable students to learn. Therefore students are required to read the chapters of the textbook before coming to class and solve the related homework questions after each lecture. The instructor will lecture in class by writing on the board and some lectures will be given as a MS power point presentation. Also the lectures will be supplemented by tutorial sessions. | | | | | |
| **READING ASSIGNMENTS**  Besides the textbook material, there will be some reading assignments, which will support the lectures. For any type of examination, students are also responsible from studying all assigned readings, even if they might not be discussed in class. | | | | | |
| **METHOD OF ASSESSMENT**  Although the student’s overall grade will be based on the general assessment of the instructor, the following percentages may give an idea about the relative importance of various assessment tools.  Quizzes 16 %  Homework 24 %  Mid-term Exam 25 %  Final Exam 35 %  TOTAL 100 points  Note that the instructor reserves the right to modify these percentages in case he finds it necessary. Letter grade equivalents of numerical performances will be announced by the Registrar’s Office after the last day for the submission of letter grades. | | | | | |
| **ATTENDANCE**   1. Attendance is mandatory. Any student who has poor attendance and/or misses an examination without providing a valid excuse will be given **NG** grade. 2. Students missing just on Midterm Exam should provide a valid excuse within three days following the examination they missed. One make-up examination will be given at the end of the semester after the final examination period. | | | | | |
| **TEXTBOOK/S**  Students must refer the following textbooks:  **Text Book**s:   * *M.S. Bazaraa, C.M. Shetty, Nonlinear Programming, Second Edition, WILEY,1997*   Reference Books:   * *Hamdy A. Taha, Operations Research: An Introduction, Prentice Hall, 7th edition, 2003.* * *Murty. Katta G, Operations Research: Deterministic Optimization Models, Prentice Hall,1995* * *Bertsekas Dimitri, Nonlinear Programming, Athena Scientific Massachusetts,1998*   **CONTENT & SCHEDULE**  The lecture topics within the semester are as in the following schedule although minor changes are possible:   |  |  | | --- | --- | | **WEEK** | **TOPICS** | | 1 | Introduction and Convex Analysis I. | | 2 | Convex Analysis II | | 3 | Optimality Conditions I | | 4 | Optimality Conditions II | | 5 | Constraint Qualification | | 6 | Lagrangean Duality (Theory) | | 7 | Lagrangean Duality (Algorithms; Bertsekas) | | 8 | **Midterm Exam** | | 9 | Unconstrained Optimization: Linear Search | | 10 | Unconstrained Optimization: Multidimensional Search | | 11 | Unconstrained Optimization: Newton’s Method | | 12 | Penalty and Barrier Functions | | 13 | Method of Feasible Direction | | 14 | Duality (Bertsekas) | | 15 | Special Problems | | 16 | **Final Exam** | | | | | | |
| **ACADEMIC HONESTY, PLAGIARISM & CHEATING**  This is intentionally failing to give credit to sources used in writing regardless of whether they are published or unpublished. Plagiarism (which also includes any kind of cheating in exams) is a disciplinary offence and will be dealt with accordingly. According to university by laws cheating and plagiarism are serious offences punishable with disciplinary action ranging from simple failure from the exam or project/report, to more serious action (suspension from the university for up to one semester). Disciplinary action is written in student records and may appear in student transcripts. Any act not suitable for a university student will not be tolerated and may lead to formal disciplinary action. Example of this are: getting someone else to take the examinations for you, misrepresentation of your own answer sheet as another’s work, cheating, knowingly assisting other students to cheat, abusing the tolerance or breaking the discipline of the class. | | | | | |

**PLEASE KEEP THIS COURSE OUTLINE FOR FUTURE REFERENCE AS IT CONTAINS IMPORTANT INFORMATION!!!**