King Fahd University of Petroleum and Minerals
Department of Mathematics & Statistics
Math 582 Syllabus, Term 211

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The Course Code and Name: Math 582, Nonlinear Programming.

The Course Credit Hours: 3-0-3. (Two lecture sessions per week.)

Instructor: Dr. Kareem Elgindy.

Lectures: Monday & Wednesday, 10:00-11:15 am.

Office Hours: Thursday, 09:00-11:00 am.

The Course Description: An advanced introduction to the theory of nonlinear programming with emphasis on convex programs. First- and second-order optimality conditions, constraint qualifications, Lagrangian convexity, and duality. Penalty function methods. Theory and algorithms of main computational methods of nonlinear programming. Representative applications of nonlinear programming in Economics, Operations Research, and Mathematics.

The Course Prerequisite: Math 412.

Learning Outcomes: After completion of the course, the student should be able to:

1. Define a nonlinear programming problem.
2. Classify nonlinear programs.
3. Derive necessary and sufficient optimality conditions for nonlinear programs.
4. Derive optimality conditions for nonlinear programs under various constraints qualifications.
5. Construct the Lagrangian dual problem of a nonlinear program and list some of its basic properties.
6. List the main algorithms to solve nonlinear programs.
7. Solve different classes of nonlinear programs using the main computational procedures.
8. Define the penalty functions of certain nonlinear programs.
9. Use the method of penalty functions to solve nonlinear programs.

Textbook: Mokhtar S. Bazaraa, Hanif D. Sherali, C.M. Shetty. Nonlinear Programming: Theory and Algorithms, Third Edition. John Wiley & Sons, Inc., 2006.

Table 1: Tentative Classes Pacing Schedule (Subject to Change)

Week	Dates	Section(s)	Topic
1	Aug. 29-Sep. 02	2.1-2.3	Convex Hulls, Closure and Interior of a Set, Weierstrass's Theorem
2	Sep. 05-09	2.4-2.6	Separation and Support of Sets, Convex Cones and Polarity, Polyhedral Sets
3	Sep. 12-16	3.1, 3.2	Definitions and Basic Properties, Subgradients of Convex Functions
National Day Holiday: Thursday, Sep. 23, 2021			
4	Sep. 19-23	3.3, 3.4	Differentiable Convex Functions, Minima and Maxima of Convex Functions
5	Sep. 26-30	3.5	Generalizations of Convex Functions
Midterm Exam: To Be Held During Oct. 03-07; Material: Chapters 2 & 3			
6	Oct. 03-07	4.1, 4.2	Unconstrained Problems, Problems Having Inequality Constraints
7	Oct. 10-14	4.3	Problems Having Inequality and Equality Constraints
Student Break: Sunday, Oct. 17, 2021			

8	Oct. 17-21	4.4	Second-Order Necessary and Sufficient Optimality Conditions for Constrained Problems
9	Oct. 24-28	6.1, 6.2	Lagrangian Dual Problem, Duality Theorems and Saddle Point Optimality Conditions
10	Oct. 31-Nov. 04	6.3, 6.4	Properties of the Dual Function, Formulating and Solving the Dual Problem
11	Nov. 07-11	6.5	Getting the Primal Solution
12	Nov. 14-18	8.6	Multidimensional Search Using Derivatives
13	Nov. 21-25	8.7	Modification of Newton's Method: Levenberg-Marquardt and Trust Region Methods
Midterm Break: Nov. 28-Dec. 02			
14	Dec. 05-09	8.8	Methods Using Conjugate Directions: Quasi-Newton and Conjugate Gradient Methods
15	Dec. 12-16	9.1, 9.2	Concept of Penalty Functions, Exterior Penalty Function Methods
Normal Thursday Class (Last Day of Classes for the Term): Dec. 20 **Final Exam: To Be Held During Dec. 22-Jan. 03; Material: Comprehensive**			

Table 2: The Course Grading Policy

Midterm Exam (written)	30% (90 points)	➢ The questions of the exams are based on the examples and exercises of the Textbook.
Homework (written)	15% (45 points)	
Project	15% (45 points)	
Final Exam (comprehensive written)	40% (120 points)	

Midterm and Final Exams Formula Sheets: Both exams will have a formula sheet when necessary that will aid students during the exams. Copies of the Formula Sheets will be available in the Blackboard for students to reference while studying before the exams. You should not print the Formula Sheet and bring the hard copy with you during the exam; instead, a copy of the Formula Sheet will be provided to you together with the exam copy on the exam day.

Project Guidelines:

- Late project report submission will not be accepted.
- Only a hard copy submission of the project report is accepted; electronic submission of the project report through email is not allowed.

Cheating in Exams: Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will result in an "**F**" grade in the course along with reporting the incident to the higher university administration.

Missing an Assessment:

- If a student misses an assessment for a legitimate reason (such as medical emergencies), she will be given a make-up assessment.

Attendance: Students are expected to attend all classes.

- If a student misses a class, she is responsible for any announcement made in that class.
- A student is considered absent if not attending the class 10 minutes after the class start time. I may also randomly verify attendance during each class using any appropriate means I find. In both cases, the student is permitted to attend the remainder of the class session.
- A student, who has a valid excuse for an absence, must present an officially authorized document to me no later than a week before the date of the Final Exam; no excuses shall be accepted after that date.
- A DN grade will be awarded to any student who accumulates
    - 6 unexcused absences in classes.

- 10 excused and unexcused absences in classes.

Usage of Calculators: Calculators are allowed in all exams.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Graduate Bulletin on the webpage of the Registrar.

Tips on How to Enhance Your Problem-Solving Skills:

- Make sure you understand the concepts and techniques of each section.
- Take notes during classes and study your notes, textbook, and my lecture slides before our next class.
- Try always to solve the problems on your own first before reading the solution or asking for help.
- If you find it difficult to solve a certain type of problems, you should try more problems of that type.
- Try to make good use of my office hours.
- Solve old exams as part of your preparation for the Midterm and Final Exams.
- Last, but not least, consult me whenever you feel you need help understanding a concept or solving a problem.