



ÇANKAYA UNIVERSITY
Faculty of Engineering
Department of Industrial Engineering



COURSE SYLLABUS

Course Code : **IE 232**
Course Title : **Operations Research I - Modeling**
Prerequisites : IE 101 Industrial Engineering Orientation
Curriculum Year : 2

Semester : **Spring 2024**
Groups : 01 & 02
Type of Course : Compulsory
Credit : 4
ETCS : 6

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GROUP 01

	<u>Day</u>	<u>Time</u>	<u>Classroom</u>
Lectures:	MONDAY	14:20 – 15:10	H-A01
		15:20 – 16:10	H-A01
		16:20 – 17:10	H-A01
Recitation & Lab:	WEDNESDAY	11:20 – 12:10	H-A01
		12:20 – 13:10	H-A01

GROUP 02

	<u>Day</u>	<u>Time</u>	<u>Classroom</u>
Lectures:	TUESDAY	13:20 – 14:10	H-A01
		14:20 – 15:10	H-A01
		15:20 – 16:10	H-A01
Recitation & Lab:	THURSDAY	14:20 – 15:10	H-A01
		15:20 – 16:10	H-A01

Catalog Data: This is the first of a series of three Operations Research courses in our curriculum. The emphasis is on the formulation of deterministic mathematical models rather than solution techniques. The topics covered are overview of Operations Research and modeling, classification and examples of mathematical models, formulation of: linear programming models, integer and mixed-integer linear programming models, and network (flow) models; some special features of mathematical programming models.

Course Objectives: The main aims of this course are:

- to introduce an understanding of the Operations Research approach and mathematical modeling,
- to introduce formulation of linear programming models under static and dynamic settings,
- to introduce formulation of integer and mixed-integer programming models and to develop skills in representing conditions using integer variables,
- to introduce formulation of network (flow) programming models.
- to introduce usage of basic mathematical programming and optimization software packages/add-ins.

Learning Outcomes: On successful completion of the course, all students will have developed:

1. skills in building mathematical models, and
2. skills in using mathematical programming and optimization software packages.

On successful completion of the course, all students will be:

3. involved in teamwork, and
4. aware of ethical issues.

Textbook: Winston W.L. (2003), *Operations Research: Applications and Algorithms*, 4th Ed., Cengage.

Some reference books are as follows:

1. Hillier, F.S., and Lieberman, G.J. (2015), *Introduction to Operations Research*, 10th Ed., McGraw-Hill.
2. Taha, H.A. (2017), *Operations Research: An Introduction*, 10th Ed., Pearson.

Note that aside from these books; University Library has quite a good collection of books on the introductory and advanced level in scheduling, which can be searched at <http://www.cankaya.edu.tr>

Course Web Site: Course related materials including the lecture notes, homework and lab work assignments, exam evaluation results, and announcements will be uploaded to the webonline site of the course on the link <http://webonline.cankaya.edu.tr> so that they can be reached at any time.

Course Outline: The outline of the topics is given below, and the instructor reserves the right to make changes on the sequence of the topics as he sees necessary.

Week	Topic(s)
1	Introduction to Operations Research and Model Building, Classification and Examples of Mathematical Models (Deterministic vs Stochastic, Linear vs. Nonlinear, Single vs. Multi-Objective, Static vs. Dynamic)
2	Linear Programming Models: Knapsack, Diet, Workforce Scheduling Problems
3	Linear Programming Models: Blending, Financial Planning Problems
4	Linear Programming in Multi-Period Models: Production and Inventory Models, Rolling-Horizon Concept, Multiple Products, Backlogging, Lost Sales
5	Linear Programming in Multi-Period Models: Production Smoothing, Financial Planning, Workforce Scheduling Problems
6	Integer Programming Models: Classification, Binary Variables, Logical Conditions, Team Formation Problem, Facility Location Problem
7	Integer Programming Models: Models with Fixed Costs
8	Integer Programming Models: Assignment Problem
9	Integer Programming and Network Flow Models: Transportation and Transshipment Problems
10	Some Special Features of Mathematical Programming Models: Converting Minimization and Maximization Models into Each Other, Unrestricted-in-Sign Variables, Absolute Values, Linearizing a Minimax (or Maximin) Objective, Linearizing the Multiplication of Variables, Constraint with k Possible Values, If-Then Constraints, Enforcing Disjunctions, Piecewise Continuous and Discontinuous Linear Functions
11	Network Flow Models: Set Covering, Set Packing and Set Partitioning Problems, Cutting-Stock Problem
12	Network Flow Models: Shortest Path Problems
13	Network Flow Models: Maximum-Flow Problem, Minimum-Cost Flow Problem
14	Network Flow Models: Minimum Spanning Tree Problem, Traveling Salesperson Problem

Lectures: Each week, there will be three hours of lectures. To be familiar with the material presented in lectures and participate in class discussions, students are expected to read the material covered in the previous lectures prior to the new class meeting. If the students come prepared, then they will find the lectures more interesting, and will benefit from the discussion.

Recitations &

Lab Sessions: Each week, there will be one hour of recitation and one hour of lab session.

- During the recitations, the teaching assistant solves problems related to the material covered in the lectures.
- During the lab sessions, the teaching assistant enables students to learn optimization software interactively.

Lecture Notes: Lecture notes will be uploaded to the course webonline site before the lectures to give the chance to the students to take extra notes on the lecture notes.

Assignments: There will be three types of assignments: Reading, Homework, and Lab Work.

Reading Assignments: From time to time, there will be some reading assignments. For any type of examination, students are also responsible for studying all assigned readings, even if they might not be discussed in class.

Homework Assignments: In this course, homework assignments play a crucial role in ensuring students from understanding of the material that they have learned in lectures and recitations. There will be **two homework assignments** containing some discussion questions and problems.

Lab Work Assignments: In this course, lab work assignments also play a crucial role in ensuring students from understanding of the optimization software packages that they have learned during the lab work sessions. There will be **two lab work assignments** containing computer exercises.

Study Team Formation for homework and lab work assignments:

- In doing the homework and lab work assignments, students should **work in teams with three members**.
- It is the student's responsibility to find his/her team members.
- The composition of the teams cannot be changed throughout the semester. That is, if a team member wants to leave his/her study team for any reason, then he/she is **neither** allowed to join another team **nor** work alone.
- Each study team should fill out a **single copy** of the **Info Form of the Study Team**, which can be downloaded from the course's webonline site, on which the student number, name and surname, cellular phone number and e-mail of the team members are complete. Incomplete forms are not accepted.
- **If a student cannot find team members**, he/she should submit a form with his/her information only. Then, it will be assumed that he/she accepts to be assigned to a team by the instructor.
- **If two students form a team but could not find the third member**, they should submit a form with their information only. Then, it will be assumed that they accept that a third member will be assigned to their team, or they can be assigned to different teams by the instructor.
- The Info Form of the Homework Study team should only be completed **by one team member and shared with other team members**.
- By **March 6, 2024 (Wednesday); 23:30**, the electronic file (with the extension **doc** or **docx**) of the **Info Form of the Study Team** should be uploaded to the webonline site of the course **by each member of the study team** to confirm their membership in the study team.
- **In any one of the cases, where**
 - **the forms uploaded by the team members are different from each other,**
 - **the forms are incomplete,**
 - **all team members have not uploaded the form,****it will be assumed that the team has not been established. Thus, students will be assigned randomly to different teams by the instructor.**

Homework and Lab Work Report Submission:

- Each team should prepare a **single written report** for each homework and lab work assignment.
- For each homework and lab work report, the **Cover Page for the Homework and Lab Work Reports** available in the course' web site should be used as the cover page.
- **If a team member does not participate in the study of a homework or a lab work assignment**, then the other members in the team have the right **not to write** his/her name on the Cover Page. Thus, this student's grade from the assignment will be zero.
- It is expected that each team will submit an original report, which reflects only the effort of team members. Homework and lab work reports should be the teams' independent work which requires independent thought. If the members of different teams work together or one team derives the answer and then shares that answer with other teams is not an independent work. Likewise, if two teams work alone to derive their answers, compare them, and find their mistakes, and then correct them together is not independent work.
- **One of the students in each team** should upload the homework and lab work reports to the webonline site of the course *on or before* the due date and time of the assignment.
- **Late submissions** of homework and lab work reports will not be accepted.
- There will be **no makeup for the homework and lab work assignments**.

Other details regarding the homework and lab work assignments will be given later.

Computer Usage: Homework and/or lab work assignments may require the use of the optimization software packages (LINDO, GAMS, Excel Solver) used for solving linear, integer or mixed-integer programming models. For this purpose, you need to

- download GAMS (<http://www.gams.com/download>), and LINDO (<http://www.lindo.com/downloads/lnd61.zip>), and
- enable Excel Solver add-in in Microsoft Excel.

Announcements &

Uploads: It is the students' responsibility to regularly check their university e-mail accounts and the course webonline site of the course for announcements and updates.

Attendance: Students are expected to attend all lectures and be in class on time. Regular class attendance is not a sufficient condition for effective learning and success in this course. However, those students who attend lectures and study regularly are likely to benefit greatly and receive marks accordingly.

Some other information regarding the attendance is as follows:

- **A 10-minute delayed entry of the students will be permitted for each lecture, recitation, and lab hour.**
- Attendance will be taken at every lecture, recitation, and lab session hour, due to the requirement of the University's rules and regulations.
- Students' lecture attendance records will be kept by the instructor. On the other hand, the TA will keep the students' recitation and lab session attendance records.

Class participation: Class participation does not mean class attendance. Students are expected to intelligently participate in class discussions.

Academic Misconduct: Academic integrity is always expected of all students of Çankaya University, whether in the presence or absence of members of the faculty. No collaboration of any kind is permitted during the exams. All suspected cases will be treated according to the University's rules and regulations.

Honesty Policy: All students admitted to Çankaya University should declare his/her understanding and belief in the Honor Code stated by the Department of Industrial Engineering for the examinations and assignments. This statement is a reminder to uphold your obligation as a Çankaya University student and to be honest in all work submitted and exams taken in this course and all others.

Exams: There will be **one midterm exam** and the **final exam**.

- All exams will be in-class exams unless it is stated before.
- All exams will be closed-notes/closed-book type.
- All exams will have two parts. Part 1 has conceptual questions. Part 2 has problems and questions related to the optimization software packages (LINDO, GAMS, Excel Solver) used for solving linear, integer or mixed-integer programming models.
- Final exam will be **non-cumulative** (i.e., it covers only the material studied after the Midterm Exam), and will be scheduled for a day and time in the designated final exams week.
- **To discourage last minute cramming, the instructor will not answer any question from students on one day before or on the day of an exam.**
- Students should come early on the scheduled exam time because they will be seated according to a list.
- During the exams, students are **not** allowed:
 - To ask any questions.
 - To write anything on the backside of each sheet of the exam booklet.
 - To detach the papers of the exam booklet.
 - To keep cellular phones on the desks.
 - To share other students' belongings such as calculators, erasers, pencils, etc.
 - To use a cellular phone as a calculator.
 - To go out for any purpose (visiting WC, drinking, smoking, etc.). So, they should take all necessary precautions before coming to the exam, and may bring their water, biscuits, etc.

Makeup Exam Policy: Make-up exam policies are as follows:

- If a student misses an exam and has a valid, verifiable, and documented excuse (e.g., medical report) for his/her absence, a make-up exam will be given. Medical reports should be approved by Çankaya University Health Center.
- There will be no make-up for the make-up exam.
- A make-up exam format can be different from a regularly scheduled examination. For example, an oral exam can be used as a part of the make-up exam.

Objections: Any form of document concerning work, which is to be used as the basis of grading, will be shown to the student upon request. Students, who feel strongly that they have received grades that are improper, have the right of formal appeal. **Within 10 days following the announcement of the grades:**

- The objection to a grade of the homework and lab work assignments must be made to the TA.
- The objection to a grade of the midterm and final exams must be made to the instructor.

Assessment Items: The following percentages give the relative importance of various assessment tools.

<i>Assessment Item</i>	<i>Marked Out of</i>	<i>Weight (%)</i>
2 Homework	100	2 ´ 7.5
2 Lab Work	100	2 ´ 7.5
Midterm Exam	100	1 ´ 30
Final Exam	100	1 ´ 40
TOTAL		100

Note that the instructor reserves the right to modify these percentages if he deems it necessary.

Grade Improvement: The semester letter grade will only be determined based on the required work listed above and cannot be improved with additional work.

Grading Policy: Semester letter grades for the students in the Undergraduate and Graduate Programs will be assigned using the standard scales (i.e., catalog grading system described in Çankaya University regulations) below.

UNDERGRADUATE AND GRADUATE STUDENTS		
<i>Letter grade</i>	<i>Coefficient</i>	<i>Score Intervals</i>
AA	4.00	90-100
BA	3.50	85-89
BB	3.00	80-84
CB	2.50	70-79
CC	2.00	60-69
DC	1.50	50-59
DD	1.00	45-49
FD	0.50	35-44
FF	0.00	0-34

The semester letter grades for the graduate students in the Scientific Preparation Program are S (Satisfactory) and U (Unsatisfactory). For those students, the standard scales (i.e., catalog grading system described in Çankaya University regulations) are as follows:

GRADUATE STUDENTS IN THE SCIENTIFIC PREPARATION PROGRAM		
<i>Letter grade</i>	<i>Coefficient</i>	<i>Score Intervals</i>
S (Satisfactory)	-	60-100 (CC and above)
U (Unsatisfactory)	-	0-59

The catalog grading system may not be considered if the instructor deems it necessary. Thus, different score intervals may be considered.

Semester letter grades will be announced by the Registrar's Office.

Letter Grade NA: If the student does not attend **both exams (midterm and final) on their scheduled dates and attempt to take their make-up exams**, then his/her semester letter grade will be NA.

Course Evaluations: Çankaya University is committed to continuous improvement and seeks students' input to that process through their participation in course evaluation process. Your response will be processed so that, unless you wish otherwise, the course instructor will not be aware of your identity.

In addition to the end of semester evaluation, you may also provide your feedback at any time during the semester by writing (or typing) your comments on a small piece of paper without indicating your identity and sliding this paper under the door of the instructor's office.

Important Notes:

1. Please keep this course syllabus for future reference as it contains important information. It will also be available on the webonline site of the course and the department's web site.
2. You are responsible for knowing any changes to this course syllabus announced in lectures or through the webonline during the semester.
3. If you have questions on the coursework, please always refer to this syllabus to obtain the answer yourself first. If the answer is in the syllabus, then **please do not insist on asking the same question to your instructor or TA.**