**EASTERN MEDITERRANEAN UNIVERSITY**

**DEPARTMENT OF INDUSTRIAL ENGINEERING**

**IENG212/MANE212 MODELING AND OPTIMIZATION**

**COURSE OUTLINE**

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| **COURSE CODE** |  IENG212 | **COURSE LEVEL** |  Second Year |
| **COURSE TITLE** |  Modeling and Optimization | **COURSE TYPE** |  **Area Core** |
| **CREDIT VALUE** |  (3, 1, 0) 3 | **ECTS Credit Value** |  6 |
| **PRE-REQUISITE(S)** |  - | **CO-REQUISITE(S)** |  MATH241  |
| **PREPARED BY** |  Assoc. Prof. Dr. Sahand DANESHVAR  | **SEMESTER / ACADEMIC YEAR** | |Spring 2023-24 |
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| **LECTURER(S)** | Assoc. Prof. Dr. Sahand DANESHVAR |  sahand.daneshvar@emu.edu.tr  |  IE-C 109 |  +90 392 630 2773 |
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| **COURSE SCHEDULE** | Thursday 12:30-15:20 (IE-D101); Wednesday 12:30-14:20 (28 February; 24 April; 15 May) (IE-D102);**Lab Classes:** Wednesday 12:30-14:20 (21 February; 13 March; 17 April; 15, 29 May) (Lab-2);  Office Hour: Tuesday 11:30-12:20. |
| **COURSE WEB LINK** | <http://staff.emu.edu.tr/sahanddaneshvar/en> |
| **CATALOG DESCRIPTION**This course is designed to install in students the ability of conceptualization of real-life system in the form of mathematical models. Principles of model building and basic optimization concepts and approaches for problem solving will be discussed in detail. The application of these principles and concepts will be illustrated using simplified but practical problems from diverse fields of application in manufacturing and service systems. Scopes and limitations of suggested formulations will be discussed and their applications in real-life situations will be studied with the help of samples of computational experience. The emphasis will be on the building and interpretation of models rather than the solution processes. |
| **COURSE OBJECTIVES**The main objectives of this course are:1. Assumptions of and modeling in Linear Programming. (Student Outcome (SO): 1,2,4)
2. Applying the graphical solution method for two dimensional problems. (SO:1,2,6)
3. Modeling the Integer Programming problems. (SO:1,2,4,6)
4. The Transportation Problem and its heuristic solution methods (North-West Cell Method, Least Unit Cost Cell Method, Vogel Approximation Method (VAM)). (SO:1,2)
5. The Assignment Problem and its solution method (Hungarian Algorithm). (SO:1,2)
6. Modeling general Network Flow Problems. (SO:1,2,4,6)
7. Solving the Minimal Spanning Tree Problem (Prim Algorithm). (SO:1,2)
8. Modeling the Shortest Path Problem and its solution method (Dijikstra Algorithm). (SO: 1,2,4,6)
9. Modeling the Maximum Flow Problem and its solution method (Maximum Flow Algorithm). (SO:1,2,4)
10. Modeling Non-linear Programming problems. (SO:1,2)
11. Using the optimization software and interpretation of the results. (LINGO) (SO:1,2,6)
12. Introducing the engineering solutions in global, economic, environmental, and societal contexts and preparing a report (by Department Council decision). (SO:4,7)
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| **COURSE LEARNING OUTCOMES** On successful completion of this course, students are expected to develop **knowledge** and **understanding** of:1. Use of modeling in optimization problems. (Course Objective (CO): 1-10)
2. Modeling real-life situations. (CO: 2,3,5,6,7,8,9,10)
3. Solving linear programming problems by solver software. (CO: 11)
4. Basic concepts in linear Programming. (CO: 1,2,3)
5. Applying modeling and optimization in diverse fields. (CO: 2,3,5,6,7,8,9,10)
6. Role of integer programming models in industrial engineering problems. (CO: 3)
7. Transportation type models. (CO: 3,4)
8. Formulation of network models. (CO: 6,7,8,9)
9. Modelling the non-linear programming problems. (CO:10)

 On successful completion of this course, students are expected to develop **their skills** in:1. Formulation of linear and non-linear models of optimization problems. (CO: 2,3,4,5,6,8,9,10)
2. Use of computer software in optimization. (CO: 11)
3. Understanding of integer programming as a powerful modeling tool. (CO: 3)
4. Graphical analysis of simple linear models. (CO: 1,2,3)
5. Developing and solving network models. (CO: 6,8,9)

On successful completion of this course, students are expected to develop their appreciation of and respect for **values and attitudes** regarding the issues of:1. Role of linear models in industrial engineering. (CO: 1-9)
2. Importance of modeling and optimization in diverse fields of sciences and engineering. (CO: 1-10)
3. Impact of optimization software in solving models for real-life situations. (CO: 11)
4. Professional and ethical responsibility. (CO: 11,12)
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| **CONTRIBUTION OF THE COURSE TO MEETING THE REQUIREMENTS OF CRITERION 5**Mathematics and Basic Sciences : - Engineering Topics : 3 Credits (Contains Significant Design)Other : -  |
| **RELATIONSHIP OF COURSE TO STUDENT OUTCOMES**

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| **Student Outcomes** | **Level of Contribution** |
| **No**  | **Moderate** | **High** |
| (1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics | 🞏 | 🞏 | 🗹 |
| (2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors | 🞏 |  |  |
| (3) an ability to communicate effectively with a range of audiences | 🗹 | 🞏 | 🞏 |
| (4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts | 🞏 | 🗹 | 🞏 |
| (5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives | 🗹 | 🞏 | 🞏 |
| (6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | 🞏 | 🞏 | 🗹 |
| (7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies | 🗹 | 🞏 | 🞏 |

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| **GRADING CRITERIA****Exams:** All examinations will be based on lectures, tutorials, labs, assigned readings, project study or other work. To pass these exams students will need to have studied the material well in advance in order to understand the concepts, procedures and techniques. To discourage last minute cramming, the instructor and the assistants will not answer any questions from students on the day of an examination. Exams may be closed book/note type or open book/note type or both types. The type of an exam will be announced just before starting it. Students should bring their notes/books and calculators to exams considering the possibility of using them. Exam results will be announced on the notice boards as soon as the exam papers have been evaluated. Descriptions of these examinations are as follows: *Quizzes:*  Four quizzes will be taken on:  *Quiz 1: Wednesday 06 March 2024*, at *12:30-14:20 ,*  *Quiz 2: Wednesday 20 March 2024*, at *12:30-14:20 ,*  *Quiz 3: Tuesday 30 April 2024*, at *13:30-15:20,*  *Quiz 4: Wednesday 22 May 2024*, at *12:30-14:20 , ,* *Homeworks:* There will be four homeworks. Two homeworkes before and two homeworks after midterm will be given and the dead line for submission each of them is **one week** after it is presented on course web link.  *Midterm Exam:* There will be one midterm examination that covers all the material up to the date of the examination. It will be scheduled for a day in the designated mid-term exams week.  *Final Exam:* The final examination will cover all the material studied throughout the semester and has the same structure as in the midterm examination. Like the midterm exam, the final exam will be scheduled for a day in the designated final exams week.*Lab Exams:* A midterm Lab exam and a final Lab will be taken for computing the grade achieved from  Lab classes. The date of these exams will be announced in semester duration. *Make-up Exam:* **No make-up examination will be given to students who miss quizzes, and whose attendance is below 60%.** Make-up examination will only be offered to students who missed the **final, midterm and lab exams** and provided adequate documentations for the reason for their absence within five working days at the latest after the examination date. A student’s illness will only be accepted as a valid excuse if it is supported by a written report from the Health Centers. *Resit Exams:*  The resit examination will cover all the material studied throughout the semester and has the same structure as in the midterm and final examinations. This exam will be scheduled for a day in the designated resit exams week.**Note:** The students may need a calculator so they should bring their calculators to all lecture/tutorial/lab/exam hours. |
| **RELATIONSHIP WITH OTHER COURSES**It is a synthesis course of all the previously taken departmental courses and also prerequisite course for the courses IENG313 and IENG332.**LEARNING / TEACHING METHOD**Many examples will be covered and discussed in detail by the lecturer in the classrooms. The function of teaching is to enable students to learn. Therefore, students are required to search and study modelling examples and exercises from the declared books and other operations research books. Students are expected to use the library and internet in their searches and studies. The instructor will lecture in class by writing on the board and using computer presentations. |
| **ASSIGNMENTS**There will be some reading and studying assignments, which will support the lectures. For any type of examination, students are also responsible from studying all assigned materials, 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.  Lab Exams 8 %  Quizzes 20 % Homeworks 16 % Mid-term Exam 22 % Final Exam 34 % TOTAL 100 pointsFor the students who apply for Resit Exam, the grade of this exam will be replaced by Mid-term and Final Exams grades, in total grade computation. 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.**NG (Nil-grade):** **Conditions that lead to NG (Nil-grade):**1. Not completeing sufficient work that are included in the assessment of the course.
2. Not attending the **Final Exam** or its **Make-up Exam without a valid excuse**.
3. Not attending the **Mid-term Exam** or its **Make-up Exam without a valid excuse**.
4. **Having an attendance to lectures/tutorials/labs less than 60%.**

**Objections:** Any form of document concerning work that is to be used by the instructor as the basis of grading will be shown to the student upon request, **within a week following the announcement of the grade**. The objection to any grade must be made to the assistants within that period. If, after an exam has been graded, you think an error was made in grading or you have questions about the grading of the material, please examine the exam solutions first, and then write your questions or comments on a separate sheet of paper and turn this paper to the assistants. |
| **ATTENDANCE AND NG GRADE**Attendance will be taken every Lecture/Tutorial/Lab session. Note that EMU regulations allow instructors to give a grade of **NG** (Nil Grade) to a student whose absenteeism is more than 40% of the Lecture/Tutorial/Lab hours and/or who do not complete sufficient work that are included in the assessment of the course.  |
| **TEXTBOOK/S**Students must have the following textbook:* WINSTON, Wayne L., “Operations Research: Applications and Algorithms” 3rd edition, Duxbury Press 1993. ISBN: 0-534-20971-8.

**INDICATIVE BASIC READING LIST*** BAZARAA, M., “Linear Programming and Network Flows” 4th edition, Wiley, 2010. ISBN: 978-0470-46272-0.
* Taha, Hamdy A., “Operations Research”, 6th international edition, Prentice Hall 1997;
* Hillier, F.S. and G.J. Lieberman, “Introduction to Operations Research”, 7th international edition, McGraw Hill 2001;
* Beltrami, Edward J., “Models for Public Systems Analysis”, Academic Press 1977
* “LINGO”, LINDO Systems Inc.
* BENDER, Edward, “An Introduction to Mathematical Modelling”, Dover Ed.,Dover Publications,2000

**EXTENDED READING LIST**Note that aside from these books, EMU Library has quite a good collection of books on the intermediate and advanced levels in the related fields of industrial engineering discipline. |
| **TOPICS COVERED and COURSE SCHEDULE**

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| **WEEK** | **TOPICS** |
| 1 | Introduction to Optimization and Modeling |
| 2 | Basic concepts in linear programming |
| 3 | Linear programming examples, Graphical Solution for two dimensional problems |
| 4 | Introduction to integer programming, |
| 5 | Integer programming graphical solution |
| 6 | Integer programming examples |
| 7 | Integer programming examples |
| 8 | **MIDTERM EXAM** |
| 9 | The transportation Problem and its solution methods |
| 10 | The assignment Problem and its solution methods |
| 11 | Network models, The shortest path problem |
| 12 | Network models, The minimum spanning problem |
| 13 | Network models, maximum flow problem |
| 14 | Modelling of non- linear programming problems |
| 15 | **FINAL EXAM**  |

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| **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!!!**