ÇANKAYA UNIVERSITY
Faculty of Engineering

Department of Industrial Engineering
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COURSE SYLLABUS

Course Code	: **IE 474**	Semester	: **Fall' 2017**
Course Title	: **Scheduling and Sequencing**	Groups	: 01 & 02
Pre-requisites	: Preferably, IE 366 has been satisfactorily completed; otherwise, consent of the instructor	Type of Course	: Elective
Credit	: (3 0 3)	ETCS	: 5

Instructor:	Ferda Can ÇETINKAYA Associate Professor B.S., M.S., Ph.D. in I.E.	Teaching Assistant (TA):	Hale AKKOCAOĞLU Specialist, Ph.D. Student in I.E. B.S., M.S. in I.E.
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Office Hours:	To be announced later; Appointments are also accepted.		

	GROUP 01			GROUP 02		
	Day	Time	Classroom	Day	Time	Classroom
Lecture Hours:	FRIDAY	09:20 – 10:10	M-101	WEDNESDAY	09:20 – 10:10	R-B03
		10:20 – 11:10	M-101		10:20 – 11:10	R-B03
		11:20 – 12:10	M-101		11:20 – 12:10	R-B03

Course Description: This course introduces the principles, techniques and algorithms for solving machine (resource) scheduling problems of the manufacturing and service systems. The topics covered in this course are overview of terminology, characteristics and classification of scheduling and sequencing problems, an overview of computational complexity theory, single machine, parallel machines, flow shop, job shop, and open shop scheduling problems with various scheduling criteria, dispatching rules, branch-and bound, dynamic programming, local search, and metaheuristic approaches.

Course Objectives: This course aims to introduce the basic concepts to understand and describe a variety of scheduling problems faced in manufacturing and service systems, the techniques for modeling scheduling problems using appropriate mathematical models of linear and integer programming types, and a comprehensive treatment of the various types of algorithms to solve the scheduling problems.

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

1. Ability to identify basic concepts and issues for scheduling and sequencing problems in manufacturing and service systems
2. Capability to use quantitative methods to model, analyze and optimize scheduling and sequencing problems
3. Capability to formulate mathematical programming models for solving a variety of scheduling and sequencing problems, and have improved their skills in mathematical modeling
4. Skills in using basic mathematical programming and optimization software (GAMS) and coding an algorithm in a general purpose language
5. Skills in report writing
6. Ability to search and use databases for scheduling papers

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

7. Improved their team work skills
8. Awareness of ethical issues

Textbook: Although no specific textbook is suggested for the course, students are recommended to obtain a copy of one the following reference books below:

1. K.R. Baker, D. Trietsch, Principles of Scheduling and Sequencing, Wiley, 2009.
2. T.E. Morton, *Heuristic Scheduling Systems: with Applications to Production Systems*, Wiley, 1993.
3. M. Pinedo, *Scheduling Theory, Algorithms, and Systems*, Prentice Hall, 2008.
4. M. Pinedo, and X. Chao, *Operations Scheduling with Applications in Manufacturing and Services*, McGraw-Hill, 1999.
5. D. Sule, *Industrial Scheduling*, PWS Publishing, 1997.

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

Course Outline:

Week	Topic(s)
1	*Introduction*: Definition of the scheduling problem, notation, three-field representation for scheduling problems, classification of scheduling problems
2	*Introduction*: Equivalency of performance measures, regular and irregular performance measures, complexity theory, classification of solution algorithms, measuring performance of approximation algorithms
3	*Single machine scheduling problems*: Dominant sets, mathematical programming formulations, total flow time minimization, weighted flow time minimization, total lateness minimization
4	*Single machine scheduling problems*: Maximum lateness and maximum tardiness minimization, number of tardy jobs minimization, total weighted completion time minimization with precedence constraints, dynamic programming approach
5	*Single machine scheduling problems*: Neighborhood search techniques, dominance properties in total tardiness minimization, branch and bound algorithm for total tardiness minimization
6	*Parallel machines scheduling problems*: Mathematical programming formulations, list scheduling, makespan minimization, makespan minimization with preemption, mean flow time minimization
7	*Parallel machines scheduling problem*s: Mean flow time minimization with machine availability, uniform and unrelated parallel machines
8	*Metaheuristics*: Simulated annealing, tabu-search and genetic algorithms
9	*Flow shop scheduling problems*: Permutation schedules, mathematical programming formulations, two-machine makespan minimization, three-machine makespan minimization, branch and bound algorithm for makespan minimization
10	*Flow shop scheduling problems*: Heuristics for multiple machines makespan minimization, two-machine total flow time minimization by branch and bound algorithm
11	*Flow shop scheduling problems*: Flow shops with dominating machines, proportionate flow shops, ordered flow shops
12	*Job shop scheduling problems*: Two-machine makespan minimization
13	*Job shop scheduling problems*: Network representation of the job shop problem, disjunctive programming formulation, priority dispatching rules, heuristic algorithms for makespan minimization
14	*Open shop scheduling problems*: Two-machine makespan minimization, multiple machines makespan minimization

Lectures: In lectures, the instructor will discuss only selected important concepts and points. 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. Data projector will be used in lectures when necessary.

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

Reading Assignments: From time to time, there will be some reading assignments, which 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.

Project: There will be a project, which is a real-life scheduling problem that needs a solution or solution technique. The project study involves the development of a mathematical programming model and solution algorithm(s) for the problem under consideration.

Homework Assignments: There will be **three** homework assignments (1 assignment before the Midterm exam, and 2 assignments after the Midterm exam) containing some discussion questions, and problems. Homework assignments play crucial role in ensuring students from understanding of the material that they have learned in lectures.

Some notes on homework assignments and the project study:

- In doing **homework assignments and the project study**, students should work in teams of **three** or **four**.
- Each study team will be responsible for doing both homework and project assignments.
- Students from groups 01 and 02 can form a team.
- It is the student's responsibility to find his/her team members.
- The composition of the study 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 into another team **nor** work alone.
- Each member of a study team should sign up the **same copy of the** *Study Teams Info Form*, which can also be downloaded from the course's web site, on which the student number, name and surname, cellular phone number, e-mail, and signatures of the team members are complete. Incomplete forms are not accepted.
- If a student fails to form a team, and submits a form with his/her name only then he/she accepts to be assigned to a team by the instructor.
- If two students form a team but could not able to find the third or fourth member then they accept that a third or fourth member will be assigned to their team or they can be assigned to different teams by the instructor.
- It is clear that the name of each student should appear in
  - a form with his/her name only, or
  - a form with his/her name and a friend's name, or
  - a form with his/her name and two friends' names, or
  - a form with his/her name and three friends' names.
- By **October 11, 2017 (Wednesday); 11:30 a.m.**,
  - **the electronic form** should be send by e-mail to the **instructor's e-mail address** (In the electronic form, signatures of the students are not required), and
  - **the printed form with the** signatures of the students should be submitted to the **instructor**
- The assignment reports should be as professional in appearance as if you were preparing reports work or for publication, and be submitted in both electronic and printed format.
- If the answer to a question of an assignment is given in a book, don't just copy it, explain how you got it.
- It is compulsory that students submit a "homework assignment cover sheet" with each assignment. Homework assignment cover sheet, which can also be downloaded from the course's web site, will be provided by the instructor.
- Each team should submit a single written report for each homework assignment and the project study.
- Students are required to submit the assignment reports *on* or *before* the due date. The instructor may grant extension of the due date of an assignment in extenuating circumstances. Note that late submissions of reports will be accepted, but the following penalty scheme will be applied:

	Total Penalty
Delay $\leq$ 20 minutes	5 points
20 $<$ Delay $\leq$ 40 minutes	10 points
40 $<$ Delay $\leq$ 60 minutes	20 points
60 $<$ Delay	100 points (i.e., report won't be evaluated)

- It is expected that each team will submit an original report, which reflects only the effort of team members. Homework assignments and the project study should be the teams' independent work which requires independent thought. If the members of different teams work together or one team derive the answer and then share 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 an independent work. Therefore, in case of a collaborative work, the followings are going to be applied:
  - For the first incidence, the reports of the collaborative teams are going to be evaluated independently, according to the quality of the report, and then the score is going to be divided by the number of teams sharing their reports. In

other words, suppose that two teams cooperate for one of the questions given in a homework assignment, and their homework reports are marked as 90 and 80, respectively. Then, the grades for these teams will be 45 and 40, respectively.
    - For the second incidence, the score obtained for the report is going to be zero for every collaborative team.
    - For the third incidence (which means insistent copying), the score obtained for the report is going to be zero for every collaborative team, and all students having collaborative work will be treated according to the university by-laws and procedures for Disciplinary Matters.
- Homework assignments will be graded within 10 days, at the latest.

Exams: To be successful in the examinations, students will need to have studied the material well in advance in order to understand the concepts, procedures and techniques.

- There will be one midterm exam and the final exam. All exams will:
    - be held in class (i.e., no take-home exam will be given.),
    - be of closed-notes/closed-book type in the first part of the exam having multiple-choice, short-answer, and discussion questions;
    - be of open-notes/closed-book type in the second part of the exam having problem-type questions.
- Final Exam will be cumulative (i.e., it covers all materials studied throughout the semester; however, more attention will be given to the topics covered after the midterm exam), and will be scheduled for a day and time in the designated final exams week.
- In all exams, students may need a hand-calculator.
- Students should come early on the scheduled exam time because they will be seated according to a list.
- During the exams, students will not be allowed 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.
- 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.
- Exam results will be announced within 15 days, at the latest, following the exam date.

Make-up Exams: Make-up exam policies are as follows:

- If a student misses an exam and has a genuine and valid excuse for his/her absence, a make-up exam will be given. An excused absence is one that meets all of the following conditions:
    - Student's illness or death of his/her family member will be accepted as a valid excuse.
    - The instructor and the Department Chairman approve the absence.
- If the student's absence is the student's illness, then the medical report should be submitted to the University's Health Center within 7 working days following the last valid day of the medical report. Note that medical reports given by private medical doctors or medical centers may not be approved by the University's Health Center. On the other hand, if the student's absence is the death of his/her family member, then official note given by the Government Office should be submitted to the Department Chairman's Office.
- A make-up exam format can be different than a regularly scheduled examination. For example, an oral exam can be used as a part or whole of the make-up exam.
- Complementary Exam ("Bütünleme Sınavı") is a makeup exam for the final exam. Also note that the students having the letter grade NA have no rights to take the Complementary Exam.

Grade NA: The occurrence of one of the cases below will lead to grade NA:

- Without an excused absence in both exams.
- Not submitting the project study and at least two homework reports.

Solved Exercises Sets: From time to time, some sets of solved exercises will be uploaded to the course web site.

Computer Access & Usage: Some homework assignments may require the use of MS-OFFICE (Word, Excel, and Visio) and the computer software package GAMS for solving mathematical programming models of scheduling problems. It is expected that students have learned to use these software packages and general purpose language(s) in the courses offered in the previous semesters. If not, it is mainly the student's responsibility to learn them. A student may use his/her own computer if he/she owns a personal computer. The computers in the Computer Laboratories are available for the student's use. Always plan ahead if you rely on the computers in the labs. Increased demand towards the deadlines of the project reports for the courses other than IE 474 will reduce the available computer time. One should also be aware of power failures. Furthermore, students should always be courteous, considerate and in a professional manner while using the computer facilities of the University.

Course Web Site: Course related materials including the lecture notes, exam evaluation results, and announcements may be accessed form the password-protected course web site:

http://ie474.cankaya.edu.tr

Announcements: It is the students' responsibility to regularly check the course web site for updates.

Lecture Notes: Students are expected to make their own lecture notes. Instructor's lecture notes will also be uploaded to the course web site within one day before the lectures.

Paper Flow & Evaluation Results: The instructor will keep handouts not picked up in the classroom. Prompt pickups minimize losses. The instructor will also keep the graded homework reports and the exam papers. All graded homework reports and exam papers should be examined within one-week following the announcement of the report/exam results.

Class participation: Class participation does not mean class attendance. Students are expected to intelligently participate in class discussions. Silence will be considered as not being prepared for the course. 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.

Attendance: Students are expected to attend all lecture hours and examinations. Some other information regarding the attendance is as follows:

- There is no bonus for the attendance.
- Attendance will be taken every lecture hour, due to the requirement of the University's rules and regulations.
- During every lecture hour, students are responsible to remind the instructor for taking the attendance, and sign up the attendance sheet.
- Students' attendance records will be kept by the instructor.
- In case, the student does have to miss a class, it is the student's responsibility:
  - to be informed of course-related activities and the material that was covered in the class,
  - to contact someone in the class or the instructor to obtain handouts and additional course policies which are not given in this course syllabus, but mentioned in the class, and
  - to study all material covered in the class to maximize their chance of meeting the objectives of the course.

Punctuality: Students are expected to be in class on time, and latecomers will not be admitted, as arriving late to class is too disruptive. There will be normally ten-minute break between two consecutive hours in the same day; thus, students who are late will have to wait outside until the break is given.

Academic Integrity: Every student at Çankaya University should behave according to universally accepted norms of behavior and ethics. If a student participates in unlawful unacceptable activities such as:

- collusion (material copied from another team's report with that team's knowledge),
- purloining (material copied from another team's report or work without that team's knowledge),
- ghost writing (team's report written by third party and presented by a team as their own),
- verbatim copying (material copied word for word or exactly duplicated without any acknowledgement of the source),
- inappropriate/inadequate acknowledgement (material copied word for word which is acknowledged as paraphrased but should have been in quotation marks, or material paraphrased without appropriate acknowledgements of its source),
- getting someone else to take the examinations for a student,
- misrepresentation of student's exam answer sheet as another's work,
- any form of cheating and knowingly assisting other students to cheat in the examinations,
- abusing the tolerance or breaking the discipline of the class, etc.,

then he/she will be treated according to the university by-laws and procedures for Disciplinary Matters. Depending on the seriousness of the case, it can lead to a requirement to undertake additional work, failure in the course or in a part of it, suspension from the University or even permanent expulsion from the University.

Academic integrity is expected of all students of Çankaya University at all times, whether in the presence or absence of members of the faculty. Understanding this, in each exam, students will be asked to write the following honor code (or simply write "*I agree*.") with his/her own handwriting and sign underneath:

I hereby declare that I have neither given nor received any aid during the exam.

Also, note that on each student team will be asked to write following honor code on the cover page of their homework assignment reports, and each member of the team will be asked to sign underneath:

We hereby declare that, except where we have indicated, the work we are submitting in this report is our own work.

Mobile phones must be switched off during lectures and exams.

Language: The language of instruction in this course is English as the University commits it. Thus, students and the instructor should avoid the use of other languages in both their oral and written communication during lectures.

Grading Policy: 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.

Assessment Item	*Marked Out of*	*Weight* (%)
Homework Assignments	100	15
Project	100	20
Midterm Exam	100	30
Final Exam	100	35
TOTAL		100

Note that the instructor reserves the right to modify these percentages in case he deems it necessary. In general, overall grades will be assigned using the standard scales for the letter grades. Depending on the difficulty of the exams and the performance of the class, they may be curved accordingly. Semester letter grades will be announced by the Registrar's Office.

Grade Improvement: The grade for the course will only be based on the required work listed above and can not be improved with additional work.

Objections: Any form of document concerning work, which is to be used by the instructor 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. The following rules should be obeyed: The objection to any grade must be made to the instructor within 10 days following the announcement of the grades.

Office Hour: At the end of course add/drop period, the instructor will arrange their office hours. Timetables of the students and the instructor will be a base for determining appropriate time slots with zero-clash (or minimum number of clashes) as much as possible. If office hours have some clashes with other courses' lectures and recitation/lab hours, please submit a copy of your timetable to the instructor within one week following the announcement of the office hours, in order to arrange an appropriate regular time slot for you. Late submissions won't be taken into account.

If you have difficulty in understanding any material after you have tried your best, you should consult your course instructor during his office hours only. However, if you wish to meet the instructor outside of his office hours, you can communicate via e-mail or through phone calls to make an appointment, at least one day in advance.

Note that each student visiting the instructor during his office hours should sign the Office Hour Participation Sheet to give some statistical feedback about the use of the office hours by the students, and this participation data will not be used for any other purpose such as deciding the students' letter grades.

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. Please help us to help our future students by providing feedback on your experiences in this course. 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.
2. You are responsible to know any changes to this course syllabus announced in lectures during the semester.
3. If you have any question 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.