27005 - Graphs and Combinatorics

Syllabus Information

Academic Year: 2019/20
Subject: 27005 - Graphs and Combinatorics
Faculty / School: 100 -

Degree: 453 - Degree in Mathematics

ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Compulsory
Module: ---

1.General information

1.1.Aims of the course

1.2.Context and importance of this course in the degree

1.3.Recommendations to take this course

2.Learning goals

2.1.Competences

2.2.Learning goals

2.3.Importance of learning goals

3.Assessment (1st and 2nd call)

3.1.Assessment tasks (description of tasks, marking system and assessment criteria)

Grading.
For regular students two options:

a)   - Homework (Completion of four problem sets) --- 20% of the score.
    - Final exam   --- 80% of the score (with at least 32% of the score obtained   in this exam).

b)   Only a final exam (100%, different from the exam of previous section).

For non-regular students only option b).

4.Methodology, learning tasks, syllabus and resources

4.1.Methodological overview

The methodology followed in this course is oriented towards the achievement of the learning objectives. A wide range of teaching and learning tasks are implemented, such as lectures, problem-solving sessions and tutorials.

4.2.Learning tasks

This course is organized as follows:

- **Lectures** (30 hours). Two weekly sessions of 1 hour each.
- **Problem-solving sessions** (30 hours). Two weekly sessions of 1 hour each. Four problem sets will be assigned during the course. Material covered in exercises will be tested on exams. Typically, a problem set is due two weeks after it is assigned. By solving the problem sets a student can get 20% of the final score.
- **Tutorials**. The students can attend office hours and send questions to him/her teacher via email.
- **4 additional sessions** devoted to solving questions related with the homework. For these additional sessions the students are splitted into small groups.

4.3.Syllabus

This course covers elementary discrete mathematics. It emphasizes mathematical definitions and proofs as well as applicable methods.

This course will address the following topics:

Section I

- **Topic 1**.- Enumerative Combinatorics: Permutations and Combinations.
- **Topic 2**.- Binomial coefficients and binomial formula.
- **Topic 3**.- Recurrence relations. Some applications.
- **Topic 4**.- The inclusion-exclusion principle. Applications.

Section II

- **Topic 5**.- Generating Functions.
- **Topic 6**.- Rational Generating Functions.

Section III

- **Topic 7**.- Graphs: Definitions and notation.
- **Topic 8**.- Traversing a Graph. Algorithms BFS and DFS.
- **Topic 9**.- Applications of Graph Traversal: Connected components, strong components, bases.
- **Topic 10.**-The number of trees and paths of a graph.

Section IV

- **Topic 11**.- Weighted Graphs. Algorithms for the minimum spanning tree problem.
- **Topic 1**2.- The shortest path problem. Dijkstra's algorithm.
- **Topic 13**.- PERT-CPM algorithms for scheduling a set of project activities.

Section V

- **Topic 14**.- Maximum flow in a network.
- **Topic 15**.- The Ford- Fulkerson method for calculating a maximum flow.
- **Topic 16**.- Menger's theorems on connectivity of graphs.
- **Topic 17**.- Maximum matching in bipartite graphs. Hall's theorem.
- **Topic 18**.- Some NP-Hard problems on graphs.

4.4.Course planning and calendar

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class or please refer to the Faculty of Sciences website and Moodle.

4.5.Bibliography and recommended resources

Bibliography.

Main:

- Lecture notes of the course at https://moodle2.unizar.es/add/course/view.php?id=8357

Complementary books:

- Bóna, Miklós. A walk through combinatorics : an introduction to enumeration and graph theory / Miklos Bona . -

2nd ed.. Hackensack: World Scientific, 2008

- Brualdi, Richard A. : Introductory combinatorics / Richard A. Brualdi . - 5th ed. Upper Saddle River, New Jersey : Pearson Prentice Hall, cop. 2010

- Gross, Jonathan L.. Graph theory and its applications / Jonathan Gross, Jay Yellen . - 2nd ed. Boca Raton : Chapman & Hall/CRC, 2006

- Lint, Jacobus Hendricus Van. A course in combinatorics / J. H. van Lint and R. M. Wilson . - [1st Ed., 2nd. repr.] Cambridge : Cambridge University Press, 1996

- Pemmaraju, Sriram. Computational discrete mathematics : combinatorics and graph theory with mathematica / Sriram Pemmaraju, Steven Skiena . 1st publ., repr. Cambridge : Cambridge University Press, 2009

- Stanley, Richard P.. Enumerative combinatorics / Richard P. Stanley . Cambridge ; New York : Cambridge University Press, cop. 1997-1999

http://biblos.unizar.es/br/br_citas.php?codigo=27005&year=2019