The University of Jordan

Accreditation & Quality Assurance Center

# Course Syllabus

# Course Name: Combinatorial Analysis

| **1** | Course title | **Combinatorial Analysis** |
|---|---|---|
| **2** | Course number | (0301443) |
| **3** | Credit hours (theory, practical) | 3 |
| | Contact hours (theory, practical) | 3 |
| **4** | Prerequisites/corequisites | (0301241) |
| **5** | Program title | B.Sc. |
| **6** | Program code | |
| **7** | Awarding institution | The University of Jordan |
| **8** | Faculty | Science |
| **9** | Department | Mathematics |
| **10** | Level of course | Elective Specialization requirement |
| **11** | Year of study and semester (s) | 4th year, 1st or 2nd semesters |
| **12** | Final Qualification | B.Sc. in Mathematics |
| **13** | Other department(s) involved in teaching the course | None |
| **14** | Language of Instruction | English |
| **15** | Date of production/revision | 7/11/2017 |

## 16. Course Coordinator:

*Office number, office hours, phone numbers, and email addresses should be listed.*

Omar AbuGhneim, Math. Building Office 329, phone: 06-5355000 Ex. 22103, o.abughneim@ju.edu.jo
Office hours Sun 8-9, Tus and Ths 10-11, Mon and Wed 11-12.

## 17. Other instructors:

*Office numbers, office hours, phone numbers, and email addresses should be listed.*

Hasan Al-Ezeh
Emad Abuosba
Osama Alkam,
Manal Ghanem
Hasan Alnajjar

## 18. Course Description:

*As stated in the approved study plan.*

Principles of enumeration; finite difference calculus; generating functions; principles of inclusion and exclusion; introduction to the theory of graphs; circuits and graph coloring; trees, Euleran and Hamiltonian Graphs.

## 19. Course aims and outcomes:

### A- Aims:

1. Solve practical problems using the product and the sum rules, combinations, and permutations.
2. Solve problems using the Pigeonhole Principle.
3. Write combinatorial proofs.
4. Solve problems using repeated combinations and permutations.
5. Solve practical problems using distributing of objects into boxes.
6. Solve linear recurrence relations with constants coefficients.
7. Solve practical and counting problems using recurrence relations.
8. Solve practical problems using generating functions.
9. Solve practical problems using inclusion-exclusion principle.
10. Represent graphs.
11. Recognize different kinds of graphs.
12. Build new graphs out of given ones using graph operations.
13. Recognize and prove isomorphic graphs.
14. Recognize Eulearian and Hamiltonian graphs.
15. Find the chromatic number of graphs.

### B- Intended Learning Outcomes (ILOs):

Successful completion of the course should lead to the following outcomes:

**A. Knowledge and Understanding Skills:** Student is expected to

A1.      Use combinations and permutations in problems of counting.

A2.      To know the properties of the binomial expansion and to know the properties of binomial coefficients.

A3.      To know some basic notions of graph Theory, and to distinguish different types of graphs. Use graphs in solving some practical problems. Finally, to learn and distinguish Eulerian and Hamiltonian graphs.

**B. Intellectual Analytical and Cognitive Skills:** Student is expected to

B1.      Write combinatorial proofs.

B2.      Use power series as generating function and to know their properties and use them to solve practical counting problems.

B3.      Apply inclusion exclusion principle to solve some counting and practical problems. Also use recurrence relations to model and solve some counting and practical problems.

**C. Subject- Specific Skills:** Student is expected to

C1.      Use the sum and product rules of counting to solve practical problems.

C2.      Solve recurrence linear relations with constant coefficients. Then to use these in solving some counting practical problems.

**D. Creativity /Transferable Key Skills/Evaluation:** Student is expected to

D1.      Solve practical problems using distributing of similar and non-similar objects to similar and non-similar boxes.
D2.      Use the Pigeonholes principle for solving different types of problems from easy ones to much more exotic ones.

## 20. Topic Outline and Schedule:

| Topic | Week | Instructor | Achieved ILOs | Evaluation Methods | Reference |
|---|---|---|---|---|---|
| Counting techniques<br>- Basics of counting, the product and the sum rules. Exclusion-Inclusion principle. The Pigeonholes principle. Some more elegant applications on the Pigeonhole, Principle.<br><br>- Permutations, combinations and combinatorial proofs. Binomial Theorem and combinatorial proofs of some important identities. Generalized permutations and combinations. Distributing of objects into boxes. | 1-5 | | A1, A2 B1, C1, D1, D2 | Exams | |
| Advanced counting techniques<br>Recurrence relations, solutions of recurrence relation. Generating functions and the method of a using them to solve recurrence relations. More Applications on the Exclusion and Inclusion Principle. | 6-10 | | B2, B3, C2 | Exams | |
| **Graphs**<br>- Graph Terminology, Types of graphs, Representation of Graphs and Isomorphisms and connectivity.<br>- Euler and Hamiltonian paths and Planar graphs.<br>- Graph Colouring and tree (if time permits). | 11-15 | | A3 | Exams | |

## 21. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

In order to succeed in this course, each student needs to be an active participant in learning – both in class and out of class.
- Class time will be spent on lecture as well as discussion of homework problems and some group work.
- To actively participate in class, you need to prepare by reading the textbook and doing all assigned homework before class (homework will be assigned each class period, to be discussed the following period).
- You should be prepared to discuss your homework (including presenting your solutions to the class) at each class meeting - your class participation grade will be determined by your participation in this.
- You are encouraged to work together with other students and to ask questions and seek help from the professor, both in and out of class. But you have to write your homework by yourself (You are not allowed to seek help in writing your homework and you are not allowed to copy from others)

## 22. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

| ILO/s | Learning Methods | Evaluation Methods | Related ILO/s to the program |
|---|---|---|---|
| | **Lectures** | **Exam** | **A1, A4, A5, A6, B1, C1, C2, D1** |

**23. Course Policies:**

According to university regulations, attendance is mandatory. If a student is unable to attend a class, then he/she should contact the instructor. If a student misses more than 10% of the classes without excuse, then he/she will be assigned a falling grade in class.

In cases of extreme emergency or serious illness, the student will be allowed to make up the missed exams. Times and dates for makeup exams will be assigned latter.

There are severe sanction for cheating, plagiarizing and any other form of dishonesty. The university regulations on cheating will be applied to any student who cheats in exams or on any homework.

**24. Required equipment:**

Data Shows

**25. References:**

A- Required book (s), assigned reading and audio-visuals:

Discrete Mathematics and its Applications by K. Rosem (Fifth Edition).

B- Recommended books, materials, and media:

1. Discrete and Combinatorial Mathematics, An applied Introduction by Ralph P. Grimaldi, Addison Wesley.
2. Introduction to Combinatorial Mathematics by Lin C. L., McGraw-Hill, New York.

**26. Additional information:**

Name of Course Coordinator:: Dr. Omar AbuGhneim -Signature: ------------------------ Date: -8-11-2017

Head of curriculum committee/Department: Dr. Emad Abu Osba Signature: --------------------------------

Head of Department: Dr. Baha Alzalg  Signature: --------------------------------

Head of curriculum committee/Faculty: Dr. Amal Al-Aboudi Signature: --------------------------------

Dean: Dr.  Sami Mahmoud  Signature: --------------------------------

<u>Copy to:</u>
Head of Department
Assistant Dean for Quality Assurance
Course File