King Saud University
College of Science
Department of Mathematics

Course specification

Combinatorics and Graph Theory (1), MATH431

(A mandatory course)

1432H/2011G

Institution : King Saud University
College/Department : College of Science / Department of Mathematics

A Course Identification and General Information

1. Course title and code: Combinatorics and Graph Theory (1), MATH431
2. Credit hours : 4(3+1+0)
3. Program(s) in which the course is offered. Bachelor of Science Mathematics
4. Name of faculty member responsible for the course Dr. Ahmad Sharary , Dr. Mohammad Alzohairi / for males Dr. Fardous Tawfic / for females
5. Level/year at which this course is offered: Seventh level / Fourth year
6. Pre-requisites for this course (if any) : Linear Algebra (MATH246)
7. Co-requisites for this course (if any): None
8. Location if not on main campus: At Diriya, Main campus: College of Science, Building No. 4 (for males), At Malaz (for females).

B Objectives

Students enrolled in this course will be introduced to:
1- Basic counting principles,
2- Generating functions,
3- Recurrence relations,
4- Basic concepts in graph theory,
5- Some classes of graphs,
6- Coloring of graphs.

1. Summary of the main learning outcomes for students enrolled in the course.

After studying this course, the student is expected to be able to:
- Prove identities combinatorially,
- Use the inclusion-exclusion principle to solve a variety of combinatorial problems,
- Solve recurrence relations using characteristic roots and generating functions,
- Use generating functions to solve some counting problems,
- Characterize Eulerian graphs, Hamiltonian graphs, trees, and planar graphs,
- Use coloring theorems and chromatic polynomials to find the chromatic number of a graph.

2. Briefly describe any plans for developing and improving the course that are being implemented. (eg increased use of IT or web based reference material, changes in content as a result of new research in the field)

-Changes in the content of the course depend on the changes in the B.Sc. program offered by the department of mathematics.
-Teaching techniques depend on the number of students in class which varies from 5 to 20 students.

C. Course Description (Note: General description in the form to be used for the Bulletin or Handbook should be attached)

1 Topics to be Covered

List of Topics	No of Weeks	Contac thours
Basic counting methods	3	9
Generating functions	2	6
Recurrence relations	2	6
Basic concepts of graph theory	4	12
Eulerian and Hamiltonian graphs	1	3
Trees	1	3
Planar graphs	1	3
Colouring of graphs	1	3

2 Course components (total contact hours per semester):				
Lecture: 45	Tutorial: 30	Laboratory ///	Practical/Field work/Internship ///	Other: ///

3. Additional private study/learning hours expected for students per week. (This should be an average :for the semester not a specific requirement in each week)

6 hours per week

4. Development of Learning Outcomes in Domains of Learning

For each of the domains of learning shown below indicate:

- A brief summary of the knowledge or skill the course is intended to develop;
- A description of the teaching strategies to be used in the course to develop that knowledge or skill;
- The methods of student assessment to be used in the course to evaluate learning outcomes in the domain concerned.

a. Knowledge

(i) Description of the knowledge to be acquired

-Basic counting methods: rules of correspondence, sum and product. Sample and distribution models of counting. Sequences, permutations, combinations and multisets. Binomial and multinomial theorems. Identities.Pigeonhole principle. The inclusion-exclusion principle. Derangements.

-Generating functions: Ordinary generating functions and exponential generating functions. Extraction of the coefficients of generating functions. Modelling problems with generating functions.
-Recurrence relations: Homogeneous linear recurrence relations with constant coefficients, method of characteristic roots. Nonhomogeneous linear recurrence relations with constant coefficients. Particular solutions. Solution of recurrence relations by the technique of generating functions. Modelling with recurrence relations.
-Basic concepts of graph theory: Basic definitions and examples, subgraphs, paths, cycles, connectedness, connected components, bridges. Regular, complete and bipartite graphs. Degree sequences. Isomorphism of graphs. Matrix representations of graphs.

- Eulerian and Hamiltonian graphs: Definitions, examples and characterizations of Eulerian and semieulerian graphs. Fleury's algorithm. Definitions, examples and properties of Hamiltonian and semihamiltonian graphs. -Trees: Basic definitions, examples and characterizations of trees. Spanning trees,depth-first search and breadth-first search. Minimum spanning trees, Prim's and Kruskal's algorithms. -Planar graphs: Basic definitions. Euler's formula. Kuratowski's theorem. -Colouring of graphs: Vertex colourings, chromatic number. Brook's theorem. Characterization of 2-colourable graphs. The four colour problem. Chromatic polynomials and reduction theorems.
(ii) Teaching strategies to be used to develop that knowledge - Lectures -Homework assignments. -Tutorial discussions.
(iii) Methods of assessent of knowledge acquired -Exams -Evaluation of performance in tutorials.
b. Cognitive Skills
(i) Description of cognitive skills to be developed - Ability to solve problems in basic graph theory and combinatorics. -Ability to give combinatorial proofs. -Ability to construct combinatorial models.
(ii) Teaching strategies to be used to develop these cognitive skills -Homework assignments -Problem solving in the tutorial sessions.
(iii) Methods of assessment of students cognitive skills -Quizzes -Exams -Checking the problems solved in homework assignments.

c. Interpersonal Skills and Responsibility
(i) Description of the interpersonal skills and capacity to carry responsibility to be developed -Students can complete writing assignments in due time. -Students can participate in class discussions. -Students can communicate results of work to others.
(ii) Teaching strategies to be used to develop these skills and abilities -Solving problems as individuals and in groups. -Presenting solutions of problems during tutorial sessions.
(iii) Methods of assessment of students interpersonal skills and capacity to carry responsibility -Assessment of students performance, class participation and seriousness during lectures and tutorial sessions. -Grading of assignments submitted in due time.
d. Communication, Information Technology and Nmerical Skills
(i) Description of the skills to be developed in this domain. -Writing proofs and solutions.
(ii) Teaching strategies to be used to develop these skills -Homework assignments
(iii) Methods of assessment of students numerical and communication skills -Grading of homework assignments.
e. Psychomotor Skills (if applicable)
1. Description of the psychomotor skills to be developed and the level of performance required ///

2. Teaching strategies to be used to develop these skills

///

3. Methods of assessment of students psychomotor skills

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5. Schedule of Assessment Tasks for Students During the Semester

Assessment	Assessment task (eg. Essay, test, group project, examination etc.)	Week due	Proportion of Final Assessment
1	First midterm exam	7	20%
2	Second midterm exam	12	20%
3	Quizzes	biweekly	10%
4	Final exam	16	50%

D. Student Support

2. Arrangements for availability of faculty for individual student consultations and academic advice. (include amount of time faculty are available each week)

- 10 office hours per week for all courses.
- 5 hours weekly for academic advice through the academic guidance unit of the department.

E Learning Resources

1. Required Text(s)
- Introduction to combinatorics(in Arabic), A. Sharary and M. Alzohairi.
- Introduction to graph theory(in Arabic), A. Sharary and M. Alzohairi (to be published).

2. Essential References

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3- Recommended Books and Reference Material (Journals, Reports, etc) (Attach List) - Discrete and combinatorial mathematics : an applied introduction, R.P. Grimaldi ; Addison-Wesley. - Applied combinatorics, A.Tucker; John Wiley and Sons. - Introduction to graph theory, Robin J. Wilson; Longman(Arabic translation by M. Alabdullatif). -Applied combinatorics, Fred S. Roberts; Prentice-Hall. - Discrete mathematics: Applied combinatorics and graph theory, M. Townsend; Benjamain/Cummings. - Introductory combinatorics, Richard A. Brualdi; Prentice – Hall.
4-.Electronic Materials, Web Sites etc Websites on the internet that are relevant to the topics of the course.
5- Other learning material such as computer-based programs/CD, professional standards/regulations ///

F. Facilities Required

Indicate requirements for the course including size of classrooms and laboratories (ie number of seats in classrooms and laboratories, extent of computer access etc.)
1. Accommodation (Lecture rooms, laboratories, etc.) Lecture room with 20 seats.
2. Computing resources///
3. Other resources (specify --eg. If specific laboratory equipment is required, list requirements or attach list) ///

G Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching -Course evaluation by students. -Students-faculty meetings.
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department - Discussions with the group of the faculty teaching the course.

3 Processes for Improvement of Teaching -Discussions of challenges in the classroom with colleagues. -Exchange of experience amongst faculty members. -Periodical revision of methods of teaching in tutorials.
4. Processes for Verifying Standards of Student Achievement (eg. check marking by an independent faculty member of a sample of student work, periodic exchange and remarking of a sample of assignments with a faculty member in another institution) • Unified exams and common marking if there is more than one group • Check the marking of a sample of student answer sheets in the final exam by an independent faculty member
5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. The course material and learning outcomes are periodically reviewed and changes to be taken are determined according to the new academic plans of the department of mathematics.

King Saud University

College of Science

Mathematics Department

COURSE SPECIFICATION

MATH431: Combinatorics and Graph Theory (1)

Kingdom of Saudi Arabia

The National Commission for Academic Accreditation & Assessment

COURSE SPECIFICATION

MATH 431: Combinatorics and Graph Theory (1)

June 2008

Combinatorics and Graph Theory (1), MATH431

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2. Credit hours : 4(3+1+0)
3. Program(s) in which the course is offered. (If general elective available in many programs indicate this rather than list programs) **B.Sc. in Mathematics/ College of Science**
4. Name of faculty member responsible for the course **Dr. Ahmad Sharary**
5. Level/year at which this course is offered : Fourth level / Second year
6. Pre-requisites for this course (if any) : MATH246
7. Co-requisites for this course (if any) ///
8. Location if not on main campus ///

B Objectives

1. Summary of the main learning outcomes for students enrolled in the course. After studying this course, the student is expected to be able to: - Prove identities combinatorially, - Use the inclusion-exclusion principle to solve a variety of combinatorial problems, - Solve recurrence relations using characteristic roots and generating functions, - Use generating functions to solve some counting problems, - Characterize Eulerian graphs, Hamiltonian graphs, trees, and planar graphs, - Use coloring theorems and chromatic polynomials to find the chromatic number of a graph.
2. Briefly describe any plans for developing and improving the course that are being implemented. (eg increased use of IT or web based reference material, changes in content as a result of new research in the field)

-Changes in the content of the course depend on the changes in the B.Sc. program offered by the department of mathematics.
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-Trees: Basic definitions, examples and characterizations of trees. Spanning trees,depth-first search and breadth-first search. Minimum spanning trees, Prim's and Kruskal's algorithms.

-Planar graphs: Basic definitions. Euler's formula. Kuratowski's theorem.
-Colouring of graphs: Vertex colourings, chromatic number. Brook's theorem. Characterization of 2-colourable graphs. The four colour problem. Chromatic polynomials and reduction theorems.

(ii) Teaching strategies to be used to develop that knowledge

- Lectures

-Homework assignments. -Tutorial discussions.
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-Grading of assignments submitted in due time.
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5 Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. The course material and learning outcomes are periodically reviewed and changes to be taken are determined according to the new academic plans of the department of mathematics.