King Saud University
College of Science
Department of Mathematics

Course specification

Complex Analysis, MATH487

(A mandatory course)

1423H/2011G

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

A. Course Identification and General Information

1. Course title and code: Complex Analysis, MATH487.
2. Credit hours: 4 (3+1+0)
3. Program(s) in which the course is offered: B.Sc. in Mathematics
4. Name of faculty member responsible for the course Dr. Muhammad Al-Gwaiz, Dr. Fawzi Al-Thukair, Dr. Tarek Al-Fadhel, Dr. Hocine Guediri, Dr. Borhen Halawani, Dr. Mongi Blel / for males. Dr. Maysaa' Mohamed Al Qurashi and Zainab Mansour / for females.
5. Level/year at which this course is offered: Level eight / Fourth year
6. Pre-requisites for this course (if any): Real Analysis I, MATH382.
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

In this course the student learns the following concepts:

- Manipulating complex numbers.
- Studying functions of a complex variable, (domain, continuity, differentiation).
- The concepts of holomorphic, analytic and harmonic functions, and their properties.
- Representation of complex functions by Laurent series.
- Calculation of complex integrals by means of Cauchy theory (including residues).
- Exploring complex analysis from three points of view, namely Riemann's approach, Cauchy's approach and Weierstrass' approach.

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

By the end of the course, the student should be able to:

- Deal with arithmetics of complex numbers.
- Determine the domain of a complex variable function.
- Study the continuity of a complex variable function.
- Calculate the derivative of a complex variable function.
- Characterize holomorphic (analytic) functions and harmonic ones.
- Represent complex variable functions as Laurent series.
- Calculate some integrals by making use of Cauchy theory and residues.

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)

- Exploring computers in teaching to support presenting the material.
- Providing a website for the material accessible for all students.
- Giving homework assignments periodically and providing graders to mark them, in order to keep the students following the course.
- Improving the content depending on the demand of the college of science.

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	Contact hours
Complex numbers: Algebraic (arithmetic properties). Complex (and extended) plane (Cartesian and Polar forms of complex numbers). Powers and roots of complex numbers. Planar sets (aspects of connectedness).	2	6
Functions of a complex variable: Limits and continuity. Differentiability and holomorphy. Cauchy-Riemann theory. Harmonic functions (real).	3	9
Elementary functions: Exponential, Trigonometric and hyperbolic functions. Logarithmic functions and Branch concepts. The inverses of such functions.	2	6

Complex integration: Contour (line) integrals. Cauchy's theorem. Cauchy's integral formula and its applications (such as: Maximum modulus principle, Mean value property (analytic and harmonic), Cauchy's estimate, Liouville's theorem, Fundamental theorem of algebra…).	3	9
Series representation of analytic functions: Sequences and infinite series. Taylor series. Power series and analyticity. Laurent series.	2	6
Residue theory: Zeros and singularities of complex variable functions. The residue theorem. Applications to trigonometric integrals. Application to improper integrals.	3	9

2 Course components (total contact hours per semester):

Lecture:	Tutorial:	Laboratory	Practical/Field work/Internship	Other:
45 hours	30 hours	Not applicable	Not applicable	None

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)

5 hours a week for homework and revision.

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 be used in the course to evaluate learning outcomes in the concerned domain.

a. Knowledge

(i) Description of the knowledge to be acquired

- A knowledge of complex numbers and basics of complex variable functions.

• Absorbing the fundamental concepts, namely: Holomorphy, Analyticity, Harmonicity, Branches, Complex integrals, Cauchy's theory and its consequences, Maximum modulus principle. • Series representation of analytic functions and Laurent series. • Calculating integrals by means of the residue method.
(ii) Teaching strategies to be used to develop that knowledge • Lectures. • Consulting instructors through office hours. • Activity within tutorial sessions. • Homework assignments. • Proposing typical problems from textbooks to be solved.
(iii) Methods of assessment of knowledge acquired • Homeworks. • Quizzes in tutorial classes. • Two mid-term exams. •Final exam. • Evaluation of activities during lectures and tutorials.
b. Cognitive Skills
(i) Description of cognitive skills to be developed • Absorbing the three approaches to complex function theory, namely Riemann's, Cauchy's and Weierstrass' theories. • Pointing out the main goals of the course and connecting previous knowledge to the lectures material. • Providing typical practical examples for various concepts of the material.
(ii) Teaching strategies to be used to develop these cognitive skills • Orienting the students to how to think about formulating mathematical models

through discussions during the lectures.

- Learning them how to come up with original solutions to problems.
- Homework assignments and mini-projects.
- Using sophisticated technology (computers).

(iii) Methods of assessment of students cognitive skills

- Oral exams. Exams, Efforts in tutorial sessions, Quizzes.
- Discussions and approaches to deal with problems.

c. Interpersonal Skills and Responsibility

(i) Description of the interpersonal skills and capacity to carry responsibility to be developed

Learning the students how to deal with a given problem and how to provide independent related approaches.

Helping them to learn how to expose and freely discuss any encountered problems.

Learning them how to write and present homework solutions (and even exam copies) in a readable form.

(ii) Teaching strategies to be used to develop these skills and abilities

Exploring various sophisticated resources related to the material.

Correcting homework assignments and orienting students to adequate presentations of homework solutions.

Giving a lot of examples and Solving exam samples.

(iii) Methods of assessment of students interpersonal skills and capacity to carry responsibility

Grading of assignments submitted in due time.

Routine check of students' comprehension of the course.
Encouraging students to participate in educational competitions.

d. Communication, Information Technology and Numerical Skills

(i) Description of the skills to be developed in this domain. Writing proofs and solutions. Exploration of computational resources (computers….etc). Editing and exposing homework solutions by means of text editors. Participating in online scientific forums.
(ii) Teaching strategies to be used to develop these skills Encouraging students to benefit from various available facilities and to update their computational skills, namely that it has been developing crazily fast nowadays. Guiding them to explore various available internet resources serving the course.
(iii) Methods of assessment of students numerical and communication skills Mainly through forums and educational competitions. In other words, one may evaluate the provided efforts during educational competitions, which must be encouraged and supported by offering prizes to distinguished participants.
e. Psychomotor Skills (if applicable)
(i) Description of the psychomotor skills to be developed and the level of performance required Not applicable.
(ii) Teaching strategies to be used to develop these skills Not applicable.
(iii) Methods of assessment of students psychomotor skills Not applicable.

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 Assessme

			nt
1	First midterm	6th Week	20%
2	Second midterm	10th Week	20%
3	Homework and tutorial activities, Quizzes	Over all weeks	10%
4	Final exam	By the end	50%

D. Student Support

1. Arrangements for availability of faculty for individual student consultations and academic advice. (include amount of time faculty are available each week) - Ten office hours homogeneously distributed on the week days and - Five hours per week for academic advice provided by the academic advising unit.

E. Learning Resources

1. Required Text(s): J. W. Brown & R.V. Churchill: Complex Variables and Applications. 8th Edition, McGraw-Hill Companies, 2008.
2. Essential References: **1.** M.A. Al-Gwaiz: Complex Variables and Applications, King Saud University Press, Riyadh, 1988. (In Arabic) **2.** Saff & Snider: Fundamentals of Complex Analysis for Mathematics, Science and Engineering. Second Edition, Prentice Hall, 1993. (There is an Arabic translated version of it). **3.** W. Derrick: Complex Analysis and Applications. Second Edition, Wadsworth International Group, 1984. (There is an Arabic translated version of it).

3- Recommended Books and Reference Material (Journals, Reports, etc) (Attach List) A big deal of online internet resources.
4-.Electronic Materials, Web Sites etc Faculty websites. More generally, search engines (google, Yahoo…) provide almost all needed material.
5- Other learning material such as computer-based programs/CD, professional standards/regulations A useful free Floppy-Disk (or CD-Rom) gifted with each bought copy of Brown-Churchill book.

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.) A maximum of 25 student in each classroom.
2. Computing resources Providing computer labs well equipped with sophisticated computers, and connected to the internet network.

G. Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching Through the students course evaluation questionnaire by the end of the semester.
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department - Analysing the students course evaluation questionnaire by the end of the semester. - Discussing the remarks of the instructors.
3 Processes for Improvement of Teaching

Organizing Workshops and training periods for teachers about sophisticated teaching methods. Developing teaching skills of instructors by encouraging problem solving seminars.
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. Improving the course contents every five years and updating the course textbook and the additional references.

King Saud University
College of Science
Mathematics Department

COURSE SPECIFICATION

MATH487: Complex Analysis

Kingdom of Saudi Arabia

The National Commission for Academic Accreditation & Assessment

Complex Analysis

Math487

COURSE SPECIFICATION

Complex Analysis, MATH487

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College/Department : **College of Science/ Department of Mathematics.**

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2. Credit hours **4 (3+1+0)**
3. Program(s) in which the course is offered: **B.Sc. in Mathematics**
4. Name of faculty member responsible for the course **Several faculty members of maths. Dept. (Exp: Dr. Muhammad Al-Gwaiz, Dr. Fawzi Al-Thukair, Dr. Sadoon Al-Barahim, Dr. Tarek Al-Fadhel, Dr. Hocine Guediri).** **(Dr. Maysaa' Mohamed Al Qurashi – Females branch)**
5. Level/year at which this course is offered: **Fourth year- Level eight**
6. Pre-requisites for this course (if any): **MATH382 (Real Analysis I).**
7. Co-requisites for this course (if any): **None**
8. Location if not on main campus

B. Objectives

1. Summary of the main learning outcomes for students enrolled in the course. **Manipulating complex numbers. Dealing with functions of a complex variable (Domains-continuity-Differentiability). Analyticity, Holomorphy and Harmonicity of such functions. Representing functions in terms of Laurent series. Calculating integrals by means of Cauchy theory. In brief: understanding the three approaches to complex function theory, namely Riemann's, Cauchy's and Weierstrass' theories.**
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) **- Exploring computers in teaching to support presenting the material.** **- Providing a website for the material accessible for all students.** **- Giving homework assignments periodically and providing graders to mark them, in order to keep the students following the course.**

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Functions of a complex variable: Limits and continuity. Differentiability and holomorphy. Cauchy-Riemann theory. Harmonic functions (real).		**9**
Elementary functions: Exponential, Trigonometric and hyperbolic functions. Logarithmic functions and Branch concepts. The inverses of such functions.		**5**
Complex integration: Contour (line) integrals. Cauchy's theorem. Cauchy's integral formula and its applications (such as: Maximum modulus principle, Mean value property (analytic and harmonic), Chauchy's estimate, Liouville's theorem, Fundamental theorem of algebra…).		**9**
Series representation for analytic functions: Sequences and infinite series. Taylor series. Power series and analyticity. Laurent series.		**8**
Residue theory: Zeros and singularities of complex variable functions. The residue theorem. Applications to trigonometric integrals. Application to improper integrals.		**9**

2 Course components (total contact hours per semester):				
Lecture: **45 hours**	Tutorial: **30 hours**	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)

5 hours a week for homework and revision.

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 be used in the course to evaluate learning outcomes in the concerned domain.

a. Knowledge

(i) Description of the knowledge to be acquired

-Manipulating complex numbers and understanding the basics of complex variable functions.

-Absorbing the fundamental concepts, namely: Holomorphy, Analyticity, Branches, Complex integrals, Cauchy's theory, Maximum modulus principle.

-Calculating integrals by means of the residue method.

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

- **Consulting instructors through office hours.**
- **Activity within tutorial sessions.**
- **Homework assignments.**
- **Proposing typical problems from textbooks to be solved.**

(iii) Methods of assessment of knowledge acquired

- **Quizzes in tutorial classes.**
- **Two mid-term exams.**
- **Final exam.**
- **Evaluation of activities during lectures and tutorials.**

b. Cognitive Skills

(i) Description of cognitive skills to be developed

-Pointing out the main goals of the course and connecting previous knowledge to the lectures material.

-Providing typical practical examples for various concepts of the material.

(ii) Teaching strategies to be used to develop these cognitive skills

- Orienting the students to how to think about formulating mathematical models through discussions during the lectures.

- Teach them how to come up with original solutions to problems.

- Homework assignments and mini-projects.

-Using sophisticated technology (computers).

(iii) Methods of assessment of students cognitive skills

- Oral exams.

- Exams-Efforts in tutorial sessions- Quizzes.
- Discussions and approaches to deal with problems.

c. Interpersonal Skills and Responsibility

(i) Description of the interpersonal skills and capacity to carry responsibility to be developed

-Develop the students how to deal with a given problem and how to provide independent related approaches.

-Helping them to learn how to expose and freely discuss any encountered problems.

-Train them as to how to write and present homework solutions (and even exam copies) in a readable form.

(ii) Teaching strategies to be used to develop these skills and abilities

Exploring various sophisticated resources related to the material.

Correcting homework assignments and orienting students to adequate presentations of homework solutions.

(iii) Methods of assessment of students interpersonal skills and capacity to carry responsibility

-Routine check of students' comprehension of the course.

-Encouraging students to participate in educational competitions.

d. Communication, Information Technology and Numerical Skills

(i) Description of the skills to be developed in this domain.

-Exploration of computational resources (computers....etc).

-Editing and exposing homework solutions by means of text editors.

-Participating in online scientific forums.

(ii) Teaching strategies to be used to develop these skills

-Encouraging students to benefit from various available facilities and to update their computational skills, namely that it has been developing crazily fast nowadays.

-Guiding them to explore various available internet resources serving the course.

(iii) Methods of assessment of students numerical and communication skills **-Mainly through forums and educational competitions. In other words, one may evaluate the provided efforts during educational competitions, which must be encouraged and supported by offering prizes to distinguished participants.**
e. Psychomotor Skills (if applicable)
(i) Description of the psychomotor skills to be developed and the level of performance required **Not applicable.**
(ii) Teaching strategies to be used to develop these skills **Not applicable.**
(iii) Methods of assessment of students psychomotor skills **Not applicable.**

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.**	**6th Week**	**20%**
2	**Second mid term exam.**	**10th Week**	**20%**
3	**Homework and tutorial activities**	**Over all weeks**	**10%**
4	**Final exam**	**By the end**	**50%**

D. Student Support

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

E. Learning Resources

1. Required Text(s):

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2. Essential References:

1. M.A. Al-Gwaiz: Complex variables and applications. (In Arabic)
2. Saff & Snider: Complex variables and applications. (There is an Arabic translated version of it)
3. W. Derrick: Complex Analysisand applications. (There is an Arabic translated version of it)

3- Recommended Books and Reference Material (Journals, Reports, etc) (Attach List)

A big deal of online internet resources.

4-.Electronic Materials, Web Sites etc Faculty websites. More generally, search engines (Google, Yahoo…) provide almost all needed material.
5- Other learning material such as computer-based programs/CD, professional standards/regulations A useful free Floppy-Disk (or CD-Rom) gifted with each bought copy of Brown-Churchill book.

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.) A maximum of 25 students in each classroom.
2. Computing resources **Computer labs equipped with sophisticated machines.** **Increasing the capacity of the internet network in order to accommodate more users.**

G. Course Evaluation and Improvement Processes

1 Strategies for Obtaining Student Feedback on Effectiveness of Teaching **Discussing with the instructors of subsequent courses requiring the relevant course, mainly regarding the ability of the students to take these courses.**
2 Other Strategies for Evaluation of Teaching by the Instructor or by the Department **Discussions and Forums.**
3 Processes for Improvement of Teaching **Organizing Workshops and training periods for teachers about sophisticated teaching methods.** **Developing teaching skills of instructors by encouraging problem solving seminars.**
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)
5. Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement. **Updating the course contents and providing periodic evaluations of students' abilities.**