Course Specifications

Course Title:	**Complex analysis**
Course Code:	**30114104-4**
Program:	**BSc. Mathematics 301100**
Department:	**Mathematics**
College:	**Al Leith University College**
Institution:	**Umm Al-Qura University**

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A. Course Identification

1. Credit hours:	4 hours
2. Course type	
a.	University ☐ College ☐ Department ■ Others ☐
b.	Required ■ Elective ☐
3. Level/year at which this course is offered:	Eighth Level / Fourth Year
4. Pre-requisites for this course (if any)**:**	Real Analysis (1) 30113102-3
5. Co-requisites for this course (if any)**:**	Does not exist

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	(4 hours) x (15 Weeks)	100%
2	**Blended**	0	0%
3	**E-learning**	0	0%
4	**Correspondence**	0	0%
5	**Other**	0	0%

7. Actual Learning Hours (based on academic semester)

No	Activity	Learning Hours
Contact Hours		
1	**Lecture**	60 hours
2	**Laboratory/Studio**	0
3	**Tutorial**	0
4	**Others** (Exam)	10 hours
	Total	70 hours
Other Learning Hours*		
1	**Study**	60 hours
2	**Assignments**	25 hours
3	**Library**	15 hours
4	**Projects/Research Essays/Theses**	15 hours
5	**Others** (specify)	0
	Total	115 hours

* The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

B. Course Objectives and Learning Outcomes

1. Course Description

This is an introductory course to Complex Analysis at an undergraduate level. Complex Analysis, in a nutshell, is the theory of differentiation and integration of functions with complex-valued arguments $z = x + i\,y$, where $i = (-1)^{1/2}$. While the course will try to include rigorous proofs for many - but not all - of the material covered, emphasize will be placed on applications and examples. Complex Analysis is a topic that is extremely useful in many applied topics such as numerical analysis, electrical engineering, physics, chaos theory, and much more, and we will see some of these applications throughout the course. In addition, complex analysis is a subject that is, in a sense, very complete. The concept of complex differentiation is much more restrictive than that of real differentiation and as a result the corresponding theory of complex differentiable functions is a particularly nice one - as you will hopefully agree at the end of the course.

2. Course Main Objective

The focus of this course is on the study of holomorphic functions and their most important basic properties. Topics covered are: Complex numbers and functions; complex limits and differentiability; elementary examples; analytic functions; complex line integrals; Cauchy's theorem and the Cauchy integral formula; Taylor's theorem; zeros of holomorphic functions; Rouche's Theorem; the Open Mapping theorem and Inverse Function theorem; Schwarz' Lemma; automorphisms of the ball, the plane and the Riemann sphere; isolated singularities and their classification; Laurent series; the Residue Theorem; calculation of definite integrals and evaluation of infinite series using residues; Montel's Theorem and the Riemann Mapping Theorem.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	**Knowledge:**	
1.1	Recall the algebraic and geometric structure of the complex number system	K3
1.2	Describe the main properties of complex variable function: limits, continuity and differentiability	K1
1.3	Identify the correspondence of the elementary functions seen in calculus with the functions of a complex variable	K3
1.4	Examine residues to evaluate the improper integrals	K5
1.5	Recognize series representation of analytic functions	K1
2	**Skills :**	
2.1	Classify the various forms of a complex number	S1
2.2	Use the exponential function to provide additional examples of functions reasonably simple	S9
2.3	Choose properly the parametric representation for any given arc to calculate the integral of a complex function	S5
2.4	Write correctly the Laurent series of a complex function	S5
3	**Competence:**	
3.1	Write clear and precise proofs of the main results	C3
3.2	Develop the theories, methods and techniques of the course to solve complex mathematical problems	C2
3.3	Generalize mathematical concepts in problem-solving through integration of new material and modeling	C5

C. Course Content

No	List of Topics	Contact Hours
1	Complex Numbers (Basic Algebraic, Vectors and Moduli, Conjugates, Exponentials, Products and Powers, Roots, Regions in the Complex Plane)	8
2	Analytic Functions (Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic Functions, Harmonic Functions)	12
3	Elementary Functions (Exponential, Logarithm, Complex Exponents, Trigs, Hyperbolic Functions)	8
4	Integrals (Definite Integrals, Contour Integrals, Antiderivatives, Cauchy-Goursat Theorem, Cauchy Integral Formula, Liouville's Theorem, Fundamental Theorem of Algebra, Maximum Modulus Principle)	8
5	Series (Sequences, Convergence of Series, Taylor Series, Laurent Series, Absolute and Uniform Convergence, Power Series techniques)	12
6	Residues and Poles (Residues, Cauchy's Residue Theorem, Residue at Infinity, Zeros of Analytic Functions)	12
Total		

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge**		
1.1	Recall the algebraic and geometric structure of the complex number system	Lecture Tutorials	Exams (Quizzes, Midterm and Final). Written and possibly oral exam at the end of the course. In addition, compulsory work may be given during the course
1.2	Describe the main properties of complex variable function: limits, continuity and differentiability	Lecture Tutorials	
1.3	Identify the correspondence of the elementary functions seen in calculus with the functions of a complex variable	Lecture Tutorials	
1.4	Examine residues to evaluate the improper integrals	Lecture Tutorials	
1.5	Recognize series representation of analytic functions	Lecture Tutorials	
2.0	**Skills**		
2.1	Classify the various forms of a complex number	Lecture Individual or group work	Exams (Quizzes, Midterm and Final). Homework
2.2	Use the exponential function to provide additional examples of functions reasonably simple	Lecture Individual or group work	
2.3	Choose properly the parametric representation for any given arc to	Lecture	

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	calculate the integral of a complex function	Individual or group work	
2.4	Write correctly the Laurent series of a complex function	Lecture Individual or group work	
3.0	**Competence**		
3.1	Write clear and precise proofs of the main results	Lecture Individual or group work	Exams (Quizzes, Midterm and Final). Research Essays
3.2	Develop the theories, methods and techniques of the course to solve complex mathematical problems.	Lecture Individual or group work	
3.3	Generalize mathematical concepts in problem-solving through integration of new material and modeling	Lecture Individual or group work	

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Midterm Test (1)	6^{th} week	20%
2	Midterm Test (2)	12^{th} week	20%
3	Homework + Reports + Quizzes	During the semester	10%
4	Final Examination	End of semester	50%

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

-Each group of students is assigned to a particular faculty where he or she will provide academic advising during specific academic hours. Each staff will provide at least one session/week.

-There will be an academic advisor how will be a responsible for helping the student by doing the general supervision.

- The people in the library will support the students during the time of the course.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	COMPLEX VARIABLES AND IT APPLICATIONS (Eighth Edition) by James Ward Brown and Ruel V. Churchill
Essential References Materials	a) An Introduction to Complex Analysis by

	Ravi P. Agarwal • Kanishka Perera, Sandra Pinelas. b) Functions of one complex variable by John. B. Conway
Electronic Materials	https://en.wikipedia.org/wiki/Category:Complex_analysis
Other Learning Materials	Microsoft Excel

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Large classrooms that can accommodate more than 30 students
Technology Resources (AV, data show, Smart Board, software, etc.)	Data Show, Smart Board
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	None

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment	Students	Direct
Quality of learning resources	Students	Direct
Extent of achievement of course learning outcomes	Faculty Member	Direct

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)
Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	Council of the Mathematics Department	The mathematical sciences (college of applied sciences) and the mathematics (Al-Leith University College) department's first meeting of the coordinative committee
Reference No.	**4101050782**	**First meeting**
Date	**Sunday, 17 November 2019**	**Thursday, 17 October 2019**

Department Head

Dr. Ali Hassani