

# Course Specifications

|                      |                               |
|----------------------|-------------------------------|
| <b>Course Title:</b> | <b>Complex analysis</b>       |
| <b>Course Code:</b>  | <b>4044104-4</b>              |
| <b>Program:</b>      | <b>BSc in mathematics</b>     |
| <b>Department:</b>   | <b>mathematical science</b>   |
| <b>College:</b>      | <b>applied science</b>        |
| <b>Institution:</b>  | <b>Umm Al-Qura University</b> |

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## A. Course Identification

|   |                                     |                                   |  |
|---|-------------------------------------|-----------------------------------|--|
| <b>1. Credit hours:</b> 4 credit hours  |                                     |                                   |  |
| <b>2. Course type</b>   |                                     |                                   |  |
| a.  | University <input type="checkbox"/> | College <input type="checkbox"/>  | Department <input checked="" type="checkbox"/> Others <input type="checkbox"/> |
| b.  | Required <input type="checkbox"/>   | Elective <input type="checkbox"/> |  |
| <b>3. Level/year at which this course is offered:</b> 8 <sup>th</sup> level                                     |                                     |                                   |  |
| <b>4. Pre-requisites for this course (if any):</b><br>Real Analysis II (4043102-3), Real Analysis I (4043102-3) |                                     |                                   |  |
| <b>5. Co-requisites for this course (if any):</b>   |                                     |                                   |  |

## 6. Mode of Instruction (mark all that apply)

| No | Mode of Instruction   | Contact Hours | Percentage |
|----|-----------------------|---------------|------------|
| 1  | Traditional classroom | 60            | 100        |
| 2  | Blended               |               |            |
| 3  | E-learning            |               |            |
| 4  | Correspondence        |               |            |
| 5  | Other                 |               |            |

## 7. Actual Learning Hours (based on academic semester)

| No                           | Activity                        | Learning Hours |
|------------------------------|---------------------------------|----------------|
| <b>Contact Hours</b>         |                                 |                |
| 1                            | Lecture                         | 60             |
| 2                            | Laboratory/Studio               |                |
| 3                            | Tutorial                        |                |
| 4                            | Others (specify)                |                |
|                              | <b>Total</b>                    | 60             |
| <b>Other Learning Hours*</b> |                                 |                |
| 1                            | Study                           | 70             |
| 2                            | Assignments                     | 15             |
| 3                            | Library                         | 0              |
| 4                            | Projects/Research Essays/Theses | 0              |
| 5                            | Others (specify)                | 0              |
|                              | <b>Total</b>                    | 85             |

\* 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

|                              |
|------------------------------|
| <b>1. Course Description</b> |
|------------------------------|

## 2. Course Main Objective

By the end of the course the students will learn the following main concepts: a) Analytic functions. b) Elementary functions with complex variable. c) Definite integral on functions with complex variable and contour integrals. d) Convergence of complex sequence and series.

## 3. Course Learning Outcomes

| CLOs |  | Aligned PLOs |
|------|--|--------------|
| 1    | <b>Knowledge:</b>  |              |
| 1.1  | Recognize basic knowledge of complex numbers and polar coordinates Define the related basic scientific facts, concepts, principles and techniques calculus   |              |
| 1.2  | Recognize the relevant theories and their applications in basic mathematics.   |              |
| 1.3  |  |              |
| 1.4  |  |              |
| 2    | <b>Skills :</b>  |              |
| 2.1  | Develop connections of complex analysis with other disciplines   |              |
| 2.2  | Solve problems using a range of formats and approaches in basic science  |              |
| 2.3  | show the ability to work independently and within groups.  |              |
| 2.4  |  |              |
| 2.5  |  |              |
| 3    | <b>Competence:</b>   |              |
| 3.1  | Introduce elementary function and operation on these functions, and the notion of branch cut Define integral and contours on the complex plane Compute the series and Laurent series of complex function and the residue of a function |              |
| 3.2  | Compute limits of complex functions and their derivatives Knowledge if a function is analytic or not   |              |

## C. Course Content

| No | List of Topics  | Contact Hours |
|----|---|---------------|
| 1  | Analytic functions, Complex numbers and functions, Complex limits and differentiability, Elementary examples, Analytic functions  | 12            |
| 2  | Elementary Functions The Exponential Function The Logarithmic Function Branches and Derivatives of Logarithms Some Identities Involving Logarithms Complex Exponents Trigonometric Functions Hyperbolic Functions Inverse Trigonometric and Hyperbolic Functions  | 10            |
| 3  | Integrals, Definite Integrals of Functions, Contours and Contour Integrals Some Examples: examples with Branch Cuts, Antiderivatives Cauchy–Goursat Theorem, Simply Connected Domains, Multiply Connected Domains, Cauchy Integral Formula, Liouville’s Theorem and the Fundamental Theorem of Algebra, Maximum Modulus Principle | 20            |
| 4  | Series, Convergence of Sequences, Convergence of Series, Taylor Series  | 18            |

|              |  |    |
|--------------|--|----|
|              | Laurent Series, Isolated singularities and their classification, Residue Theorem: Calculation of definite integrals and evaluation of infinite series using residues |    |
| <b>Total</b> |  | 60 |

## D. Teaching and Assessment

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

| Code       | Course Learning Outcomes  | Teaching Strategies  | Assessment Methods         |
|------------|---|--|----------------------------|
| <b>1.0</b> | <b>Knowledge</b>  |  |                            |
| 1.1        | Recognize basic knowledge of complex numbers and polar coordinates<br>Define the related basic scientific facts, concepts, principles and techniques calculus   | Lectures, Tutorials and exams  | Written Exams              |
| 1.2        | 2 Recognize the relevant theories and their applications in basic mathematics.  |  |                            |
| 1.3        |   |  |                            |
| <b>2.0</b> | <b>Skills</b>   |  |                            |
| 2.1        | Introduce elementary function and operation on these functions, and the notion of branch cut Define integral and contours on the complex plane<br>Compute the series and Laurent series of complex function and the residue of a function | Lectures and Tutorials   | Written Exams              |
| 2.2        | Compute limits of complex functions and their derivatives Knowledge if a function is analytic or not  |  |                            |
| 2.3        |   |  |                            |
| <b>3.0</b> | <b>Competence</b>   |  |                            |
| 3.1        | Develop connections of complex analysis with other disciplines  | Working together<br>Brainstorming: A Method of solving problems in which all members of a group suggest ideas and then discuss them. | Group study to do homework |
| 3.2        | Solve problems using a range of formats and approaches in basic science   |  |                            |

### 2. Assessment Tasks for Students

| # | Assessment task*             | Week Due              | Percentage of Total Assessment Score |
|---|------------------------------|-----------------------|--------------------------------------|
| 1 | Midterm Test (1)             | 6 <sup>th</sup> week  | 20%                                  |
| 2 | Midterm Test (2)             | 12 <sup>th</sup> week | 20%                                  |
| 3 | Homework + Reports + Quizzes | During the            | 10%                                  |

| # | Assessment task*  | Week Due                    | Percentage of Total Assessment Score |
|---|-------------------|-----------------------------|--------------------------------------|
| 4 | Final Examination | semester<br>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

|                                       |  |
|---------------------------------------|--|
| <b>Required Textbooks</b>             | <b>COMPLEX VARIABLES AND IT APPLICATIONS</b><br>(Eighth Edition) BY<br>James Ward Brown and Ruel V. Churchill  |
| <b>Essential References Materials</b> | a) An Introduction to Complex Analysis by<br>Ravi P. Agarwal • Kanishka Perera, Sandra Pinelas.<br>b) Functions of one complex variable by John. B. Conway |
| <b>Electronic Materials</b>           | <a href="https://en.wikipedia.org/wiki/Category:Complex_analysis">https://en.wikipedia.org/wiki/Category:Complex_analysis</a>                              |
| <b>Other Learning Materials</b>       | Microsoft Excel  |

## 2. Facilities Required

| Item   | Resources  |
|--|--|
| <b>Accommodation</b><br>(Classrooms, laboratories, demonstration rooms/labs, etc.)   | -The size of the room should be proportional to the number of students <input type="checkbox"/><br>- Provide enough seats for students.<br><input type="checkbox"/> - The number of student not exceed on 30 in the classroom<br>- Library |
| <b>Technology Resources</b><br>(AV, data show, Smart Board, software, etc.)  | -Hall is equipped with a computer. <input type="checkbox"/><br>- Provide overhead projectors and related items <input type="checkbox"/><br>-Smart board  |
| <b>Other Resources</b><br>(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 |
|---|------------|--------------------|
| Student feedback through electronic facilities organized by the deanship of egistration and acceptance.<br>• Following completion of the prescribed course study in Pediatrics module, an evaluation should be conducted through the following: A student questionnaire feedback should be carried out on the | Faculty    | Direct             |
| Evaluation of the teachers by internal & external faculty members.<br>• Visiting to the classrooms.<br>• Mutual visits between colleagues and giving advices to each other after each lecture<br>• A staff questionnaire feedback about course  | Faculty    | 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

|                            |  |
|----------------------------|--|
| <b>Council / Committee</b> |  |
| <b>Reference No.</b>       |  |
| <b>Date</b>                |  |