هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T4
2020

Course Specifications

Course Title:	Theoretical Methods in Physics (4)
Course Code:	PHY2204
Program:	Physics
Department:	Physics
College:	Applied Sciences
Institution:	Umm Al-Qura University

Table of Contents

A. Course Identification

1. Credit hours:								
2. Course type								
a.	University	☐	College	☐	Department	☑	Others	☐
b.	Required	☑	Elective	☐				
3. Level/year at which this course is offered: 6/2nd year								
4. Pre-requisites for this course (if any): **Theoretical Methods in Physics (3)**								
5. Co-requisites for this course (if any):								

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	40	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	40
2	Laboratory/Studio	-
3	Tutorial	-
4	**Others** (specify) Exams/ Quizzes	-
	Total	40

B. Course Objectives and Learning Outcomes

1. Course Description

This course is a study of concepts and techniques for solving the partial differential equations (PDE) and functions of complex variables and their uses to simplify calculating complex integrals in physics. The course includes the following topics: boundary value solutions for First- and second Order PDEs, analytic functions and Cauchy-Riemann conditions, Line Integrals, Cauchy's Integral Theorem, Taylor and Laurent Series, Singularities, Residue Theorem, Analytic functions, Conformal mappings, Lagrange and Euler Equations for Calculus of Variations.

2. Course Main Objective

This course is intended to supply students with a variety of techniques for solving physics problems using partial differential equations and calculating integrals involving complex variable functions as well as Calculus f variations.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Recognize various types of partial differential equations and their applications in physics.	K1(I)
1.2		K2(I)
1.3	Verify analyticity and differentiability for complex variable functions and be familiar with the Cauchy-Riemann equations of analytic functions.	K1(I), K2(I)
1.4	Calculate Taylor or Laurent series for complex variable functions and verify convergence or divergence of such series.	K1(I), K2(I)
1.5	Use the Euler-Lagrange equation or its first integral to find differential equations for stationary paths.	K2(I)
2	**Skills :**	
2.1	Apply technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions.	S1(I), S2(I)
2.2		S2(I)
2.3	Evaluate integrals along a path in the complex plane using Cauchy's residue Theorem.	S1(I)
2.4		S1(I), S2(I)
2.5		S1(I), S2(I)
2.6	Solve differential equations for stationary paths, subject to boundary conditions.	S1(I)
3	**Values:**	
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams.	V2(I)
3.2		V1(I), V2(I)
3.3		V1(I)
3.4		V1(I)

C. Course Content

No	List of Topics	Contact Hours
1	**Partial Differential Equations:** First-Order Equations, Second-Order Equations, Separation of Variables, Laplace's Equation, Steady-State Temperature in a Rectangular Plate, Diffusion or Heat Flow Equation and the Schrödinger Equation, Steady-state Temperature in a Cylinder, The Wave Equation, Vibrating String, Vibration of a Circular Membrane, Steady-state Temperature in a Sphere, Poisson's Equation, Integral Transform Solutions of Partial Differential Equations.	10
2	**Functions of a complex variable:** Complex numbers and their algebraic properties, exponential forms and arguments, roots of complex numbers, regions in the complex plane, Analytic functions, mappings, limits, continuity, derivatives, differentiation rules, Cauchy-Riemann equation, harmonic functions, integrals of complex valued functions, contour integrals, Cauchy-integral formula, Laurent series.	10

3	**Calculus of Residues:** Singularities, Residues and poles, Cauchy Residue Theorem, Methods of Finding Residues, Evaluation of Definite Integrals, Residues at Infinity, Conformal Mapping and Applications.	10
4	**Calculus of variations:** Euler Equation, Applications of Euler Equation, Brachistochrone Problem and Cycloids, Several Dependent Variables and Lagrange's Equations, Isoperimetric Problems, Physical variational principles, Variational Notation.	10
	Total	**40**

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 and Understanding**		
1.1	Recognize various types of partial differential equations and derive heat and wave equations in 2D and 3D.	1. Lectures. 2. Discussions 3. Slides and computer simulation software may be used by the teachers to clarify concepts. 4. Problems solving 5. Students may be asked to solve some problems on computer using MATLAB language.	1- Homework assignments. 2- Group Project assignment. 3- Question – answer session in class. 4- Exams: quizzes, Mid-term, and final exams
1.2	Explaining of the correlation of solutions of PDEs on the conditions at the boundary of the spatial domain and initial conditions at time zero.		
1.3	Verify analyticity and differentiability for complex variable functions and be familiar with the Cauchy-Riemann equations of analytic functions.		
1.4	Calculate Taylor or Laurent series for complex variable functions and verify convergence or divergence of such series.		
1.5	Use the Euler-Lagrange equation or its first integral to find differential equations for stationary paths.		
2.0	**Skills**		
2.1	Apply technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions.	1. Lectures. 2. Discussions. 3. Problems solving. 4. Encourage the student to look for the information in different references. 5. Ask the student to attend lectures for practice solving problem.	**1**- Homework assignments. **2**- Group Project assignment. **3**- Question – answer session in class. **4**- Exams: quizzes, Midterm, and final exams.
2.2	Discuss the form of the solutions of PDEs based on the boundary and initial conditions.		
2.3	Evaluate integrals along a path in the complex plane using Cauchy's residue Theorem.		
2.4	Classification of singularities and poles of complex variable functions, calculus of residues and its applications in the evaluation of integrals.		
2.5	Apply the formula that determines stationary paths of a functional to deduce the		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	differential equations for stationary paths in simple cases.	6. Define duties for each chapter	
2.6	Solve differential equations for stationary paths, subject to boundary conditions, in straightforward cases.		
3.0	**Values**		
3.1	Participate effectively in multidisciplinary and/or interdisciplinary teams.	**1.** Groupe assignments **2.** Clarify deadlines for delivery of assignments, reports, and exams	**1.** Evaluate the efforts of each student in preparing the report. **2.** Evaluate the work in teams. Evaluation of students' presentations.
3.2	Accepting different ideas and respecting other opinions.		
3.3	Manage a project (modelling or simulation) with due attention to time and resource management.		
3.4	Take responsibility and take the course instructions seriously.		

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Exercises and HomeWorks	All weeks	10%
2	Participation in activities and quizzes.	All weeks	10%
3	Midterm exam	6^{th} week	30%
4	Final exam	End of the term	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 : Students are supervised by academic advisers in physics Department and the timetables for academic advice were given to the student each semester (8hrs per week).

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	Mary L. Boas, Mathematical methods in the Physical sciences, Third edition, John Wiley & Sons (2006). ISBN-13: 978-0471198260
Essential References Materials	**1.** Mathematical Methods for Physicists: A Comprehensive Guide 7th edition, by George B. Arfken, Hans J. Weber, Frank E. Harris, Academic Press is an imprint of Elsevier (2013), ISBN: 978-0-12-384654-9. **2.** Mathematical Methods for Physics and Engineering, by K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge University Press; (2006), ISBN-13: 978-0521679718.

Electronic Materials	
Other Learning Materials	MATLAB

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc).	Lecture room Labs
Technology Resources (AV, data show, Smart Board, software, etc.)	data show, software
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
Student Feedback on Effectiveness of Teaching	Students	Direct
Evaluation of Teaching	Department	Indirect
Improvement of Teaching	Program leaders	Direct
Quality of learning resources	Faculty	Direct
Extent of achievement of course learning outcomes	Program leaders	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	Dr Atif Ismail, Dr. Walid Belhadj and Prof. Khaled Abdel-Waged
Reference No.	
Date	