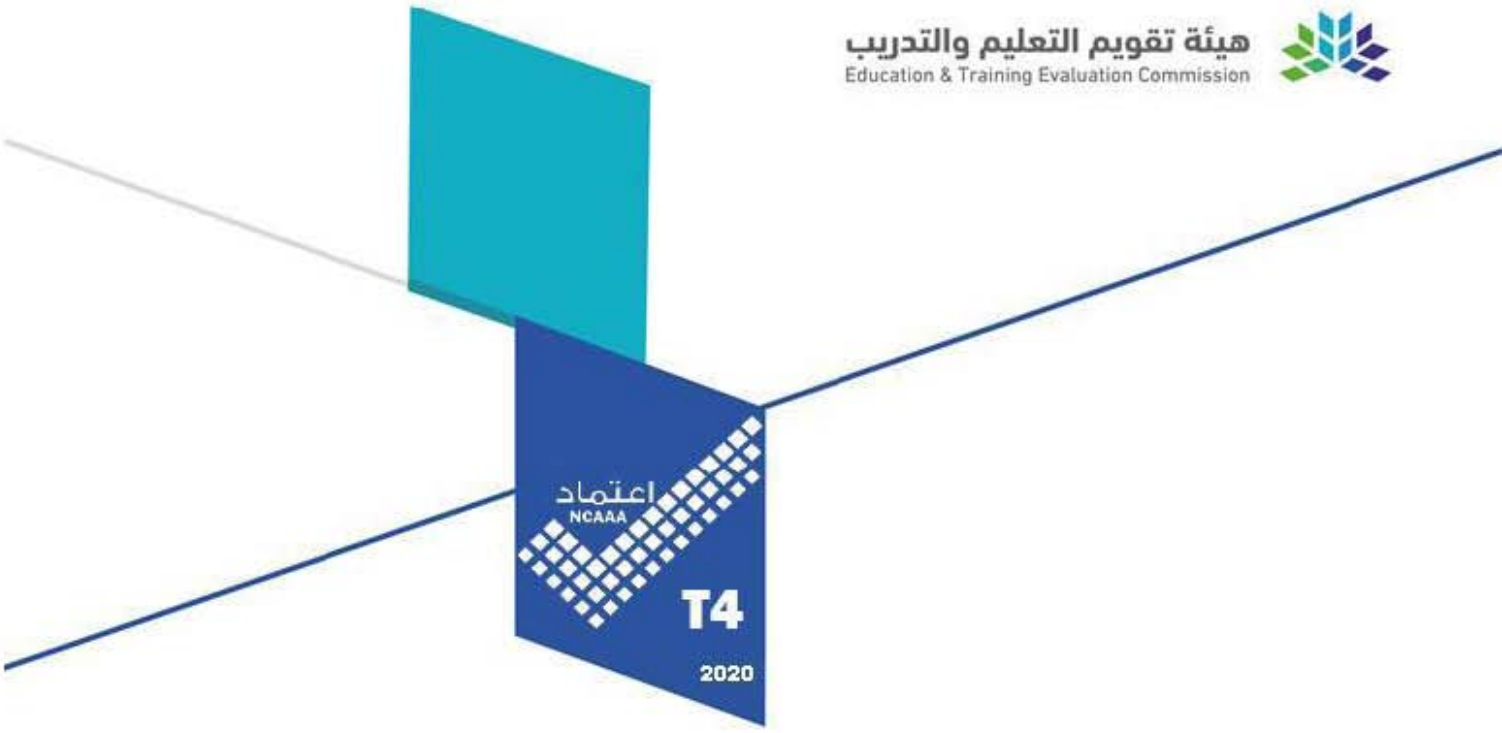
هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission



Course Specifications

Course Title:	**Theoretical Methods in Physics (3)**
Course Code:	**PHY2203**
Program:	**Physics**
Department:	**Physics**
College:	**Applied Sciences**
Institution:	**Umm Al-Qura University**

Table of Contents

A. Course Identification

1. Credit hours:	**4 hrs**
2. Course type	
a.	University ☐ College ☐ Department ☑ Others ☐
b.	Required ☑ Elective ☐
3. Level/year at which this course is offered:	5/2nd year
4. Pre-requisites for this course (if any):	Theoretical Methods in Physics (2)
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 introduces students to some special functions which arise often in physical applications. These include Gamma Function, Beta Function, Error Function, Elliptic integrals functions, Series Solutions of Differential Equations, Legendre Equation and Polynomials, Associated Legendre Functions, Bessel Functions, Hermite Function, Laguerre Functions.

2. Course Main Objective

This course is designed to supply students for a variety of Special functions that are needed to evaluate some complex integrals as well as functions that are typically found as solutions of differential equations using power series methods.

3. Course Learning Outcomes

	CLOs	Aligned PLOs
1	Knowledge and Understanding	

CLOs		Aligned PLOs
1.1	Recognize basic expressions of special functions such as Gamma and Beta functions and how to evaluate them	K1(I), K2(I)
1.2	Apply power series methodology in solving differential equations.	K1(I), K2(I)
1.3		K1(I), K2(I)
1.4		K1(I)
1.5	Compare orthogonal polynomials such as Legendre, Bessel, Hermite, and Laguerre Functions.	K1(I)
2	**Skills:**	
2.1	Explain the use the gamma function, beta function and error function to evaluate different types of integral calculus problems.	S1(I), S2(I)
2.2	Explain the usefulness of classical orthogonal polynomial functions in solving some Sturm-Liouville boundary value problem.	S1(I), S2(I)
2.3	Solving linear differential equations by power series method.	S1(I), S2(I)
2.4		S2(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	**Special functions:** Factorial function, Definition of Gamma function, Recursion relation, Properties of Gamma function, Beta Function, Beta function vs Gamma function, Error function, Stirling's formula, Elliptic integrals, and functions.	10
2	**Series Solutions of Differential Equations and Legendre functions:** Introduction to Series method for solving linear ordinary differential equations, Legendre's Equation, Rodrigues' Formula, Generating Function for Legendre Polynomials, Orthogonality and Normalization of the Legendre Polynomials, Legendre Series, Associated, Legendre Functions.	12
3	**Bessel Functions:** Bessel's Equation, Second Solution of Bessel's Equation, Graphs and Zeros of Bessel Functions, Recursion Relations, Other Kinds of Bessel Functions, Orthogonality of Bessel Functions, Approximate Formulas for Bessel Functions.	10
4	**Hermite and Laguerre Functions:** Ladder operators, Hermite functions, Hermite polynomials, Laguerre functions, Laguerre polynomials, Associated Laguerre polynomials.	8
	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 basic expressions of Gamma and Beta functions and how to evaluate them for integer and non-integer values.	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	Recognize the power series methodology in solving differential equations, and how to check the correctness of the result.		
1.3	Describe various methods of studying asymptotic behaviors of functions.		
1.4	Recognize various forms of Elliptic integrals and related functions which may arise in applied problems.		
1.5	Be familiar with classical orthogonal polynomials such as Legendre, Bessel, Hermite, and Laguerre Functions.		
2.0	**Skills**		
2.1	Explain the use the gamma function, beta function and error function to evaluate different types of integral calculus problems.	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. 6. Define duties for each chapter	**1**- Homework assignments. **2**- Group Project assignment. **3**- Question – answer session in class. **4**- Exams: quizzes, Midterm, and final exams.
2.2	Explain the usefulness of classical orthogonal polynomial functions in solving some Sturm-Liouville boundary value problem.		
2.3	Solving linear differential equations by power series method.		
2.4	Classify different types of ordinary differential equations and justify the appropriate solutions.		
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	6th 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	None

Item	Resources
(Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list).	

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	