جامعة الزيتونة الأردنية

Al-Zaytoonah University of Jordan

Course Syllabus

According to JORDAN National Qualification Framework (JNQF)

Course Name: Special Functions

Course Number: 0101455

General Course Information:

Course Title	Special Functions
Course Number	0101455
Credit Hours	3 credit hours
Education Type	Blended learning
Prerequisites/Co-requisites	Ordinary Differential Equations (1)
Academic Program	Bachelor
Program Code	
Faculty	Faculty of Science and Information Technology
Department	Mathematics
Level of Course	3
Academic Year /Semester	2023/2024 1st Semester
Awarded Qualification	BS'c
Other Department(s) Involved in Teaching the Course	-
Language of Instruction	English
Date of Production	2021-2022
Date of Revision	October 2023

Course Coordinator:

Coordinator's Name	Dr. Tareq Hamadneh
Office No.	229
Office Phone Extension Number	---
Office Hours	10-11, 13-14 Sunday, Tuesday 11-12:30 Monday, Wednesday
E-mail	t.hamadneh@zuj.edu.jo

Other Instructors:

Instructor Name	Prof. Iqbal Jibreel
Office No.	Head of Dep. Office
Office Phone Extension Number	Head of Dep. Office #
Office Hours	Head of Dep. Office (Any availability time)
Email	i.jebril@zuj.edu.jo

Course Description *(English/Arabic)*:

English	This course discusses the Frobinius method, Gamma and beta functions, Legendre polynomials functions and polynomials, Bes0sel's equation.
Arabic	يناقش هذا المساق طريقة فروبينيوس، دوال جاما وبيتا، دوال متعددات الحدود ليجيندر ومتعددات الحدود، معادلة بيسل.

Textbook: *Author(s), Title, Publisher, Edition, Year, Book website.*

1. "Special Functions for Scientists and Engineers". By W.W. Bell , Dover Publications, 2004.
2. "Special Functions for Scientists and Engineers". By; N. M. Laham and A. K. Abdullah. Yarmouk University, Irbid, Jordan 1996.

References: *Author(s), Title, Publisher, Edition, Year, Book website.*

1. "Orthogonal Functions" By G. Sansone, Dover, New York, 1991.
2. Special Functions and Orthogonal Polynomials". By Tu Diego Dominici, Robert S. Maier Tucson, Arizona.
3. "Fourier series and Orthogonal Functions". By: Harry F. Davis, Allyn and Bacon 1989.
4. Special Functions: An Introduction to the Classical Functions of Mathematical Physics, Nico M. Temme, John Wiley & Sons, 1996, ISBN: 0471113131.

Course Educational Objectives (CEOs):

CEO1	Develop a thorough understanding of various special functions, including but not limited to Bessel functions, Legendre polynomials, Hermite polynomials, and hypergeometric functions.
CEO2	Apply special functions to solve mathematical problems arising in physics, engineering, and other scientific disciplines, demonstrating the practical applications of these functions.
CEO3	Understand the asymptotic behavior of special functions, especially in the context of their applications in various domains, such as wave propagation and boundary value problems.
CEO4	Demonstrate an understanding of the orthogonality and completeness properties of special functions, and apply these properties in solving problems involving expansion in series.

Intended Learning Outcomes (ILO's):

Intended learning outcomes (ILOs)		Relationship to CEOs	Contribution to PLOs	Bloom Taxonomy Levels*	JNQF Descriptors**
1. K	Knowledge and Understanding				
2. 3. ILO1-k	Introduce the Power Series solution technique to Ordinary Differential Equations	CEO1	PLO1-k	Remembering	K
4. ILO2-k	Understand the gamma and beta functions.	CEO2	PLO2-k	Understanding	K
5. ILO3-k	Understand the Bessel and Legendre functions.	CEO2	PLO3-k	Applying	K
S	Intellectual skills				
6. 7. ILO4-s	Use the gamma function, beta function and special functions to: evaluate different types of integral calculus problems.	CEO3	PLO7-s	Understanding	S
8. ILO5-s	Solve a Boundary Value problem using Bessel and Legendre functions.	CEO4	PLO8-s	Analyzing	S
C	Subject specific skills				
9. ILO6-c	Cooperate to work effectively in the group assignments.	CEO4	PLO11-c	Applying	C
10. ILO7-c	Working independently, Team working, creative and inductive thinking.	CEO1-CEO4	PLO12-c	Applying	C

*Bloom Taxonomy Levels:						
Level #	1	2	3	4	5	6
Level Name	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
** Descriptor (National Qualification Framework Descriptors): K: Knowledge, S: Skill, C: Competency.						

Program Learning Outcome (PLOs):

(PLOs)		JNQF Descriptors**		
		K	S	C
1.	Knowledge of the main concepts in pure mathematics.	√		
2.	Knowledge of the main concepts in applied mathematics.	√		
3.	Explain concepts, principles and theories in the fields of probability and statistics.	√		
4.	Possession of technological culture related to the fields of mathematics and its applications.	√		
5.	Making use of mathematical logic in practical life.		√	
6.	Engaging scientific methodology as a way of thinking and as a tool in facing problems.		√	
7.	Applying mathematical software packages in problem solving.		√	
8.	Being capable of data analysis.		√	
9.	Capability of teaching according to modern educational techniques.		√	
10.	Develop creative and innovative methods of teaching mathematics.		√	
11.	Showing the ability to work under ethical and professional standards within teams.			√
12.	Gaining critical thinking and scientific research skills.			√

**** Descriptors according to the national qualifications framework (K: knowledge, S: skill, C: Competency)**

Weekly Schedule *(please choose the type of teaching)*

- ☐ Face to Face (F2F)
- ☒ **Hybrid** *(One – To - One)*
- ☐ Online

Schedule of Simultaneous and their Topics:

Week	First Lecture (F2F)	Second Lecture Activities	IL Os	PLOs	JNQF Descriptors *
1	Review of power series. Series solution of ordinary differential equation about an ordinary point.	Activity 1: Classification of ordinary and singular points	ILO1-k	PLO1-k	Understanding

2	Solution around regular singular point-Frobinius method	Activity 2: Solution around regular singular point, part I. Solution around regular singular point, part II.	ILO2-k	PLO2-k	Understanding
3	Solution around regular singular point, repeated roots. Definitions of factorial function.	Activity 3: Definitions of Gamma and Beta functions	ILO2-k	PLO2-k	Evaluating
4	Properties of the Gamma and Beta functions Relations between Gamma and Beta functions.	Activity 4: Definitions of the Gamma function for negative values of the argument.	ILO3-k	PLO3-k	Applying
5	Legendre's equation and its solution. Legendre polynomials and functions.	Activity 5: Generating function for the Legendre polynomials.	ILO4-s	PLO5-s	Remembering
6	Further expressions for the Legendre polynomials. Explicit expressions for and special values of the Legendre polynomials.	Activity 6: Orthogonally properties of the Legendre polynomials.	ILO5-s	PLO6-s	Remembering
7	Legendre series. Relations between the Legendre polynomials and their derivatives; recurrence relations.	Review for midterm exam	ILO5-s	PLO7-s	Applying
Midterm Exam					
9	Bessel's equation and its solutions; Bessel's functions of the first and second kind.	Activity 7: Generating function for the Bessel's functions. Integral representations for Bessel's functions.	ILO6-s	PLO8-s	Analyzing
10	Recurrence relations. Hankel functions.	Activity 8: Equations reducible to Bessel's equation.	ILO6-c	PLO9-s	Applying
11	Modified Bessel's functions.	Activity 9: Recurrence relations for the modified Bessel's functions. Kelvin's functions	ILO6-c	PLO10-s	Analyzing
12	Spherical of the Bessel function.	Activity 10: Orthonormality of the Bessel's functions; Bessel's series.	ILO7-c	PLO11-c	Analyzing

13	State the definition of the Laplace transform, and use the definition to calculate the transform of a simple function.	Activity 11: Solution of initial value problems. Transform of Unit Step functions.	ILO7-c	PLO11-c	Applying
14	Transform of periodic function. Inverse of the Laplace Transform. Translation theorems.	Review for final exam	ILO7-c	PLO12-c	Analyzing
15	**Projects Discussion**				
16	**Final Exam**				

* **K: Knowledge, S: Skills, C: Competency**

Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

- Lecture and Lab.
- Zoom and Videos
- learning through projects.
- learning through problem solving.

Course Policies:

A- Attendance policies:
The maximum allowed absences is 15% of the lectures.
B- Absences from exams and handing in assignments on time:
Midterm exam can be retaken based on approval of excuse by the instructor's discretion.
Not handing assignment on time will incur penalties.
C- Academic Health and safety procedures
D- Honesty policy regarding cheating, plagiarism, and misbehaviour:
Cheating, plagiarism, misbehaviour will result in zero grade and further disciplinary actions may be taken.
E- Grading policy:

- All homework is to be posted online through the e-learning system.
- Exams will be marked within 72 hours and the marked exam papers will be handed to the students.
- Online Activities (Course Videos, Practice labs, Discussion Forums, Quizzes) **20%**
- Midterm 30**%**
- Final Exam 50**%**

F- Available university services that support achievement in the course: **E-Learning Platform, Labs, Library.**

Required Equipment:

- PC / Laptop with webcam and mic
- Internet Connection
- Access to the ZUJ E-Learning Platform at https://exams.zuj.edu.jo/
- E-learning plan
- Satisfaction questionnaires for online and face-to-face learning.

Assessment Tools Implemented in the Course:

- Final Exam
- Midterm Exam
- Quizzes
- Homework

- Discussion Forums
- Periodic reports for learning assessment
- Improvement plans for online or face-to-face teaching.

Responsible Persons and their Signatures:

Course Coordinator	Dr. Tareq Hamadneh	**Completed Date**	**17/ 10/2023**
		Signature	
Received by (Department Head)		**Received Date**	/ /
		Signature	