Syllabus: Mathematical Physics (2) (0102282)

Second Semester 2021/2022

COURSE INFORMATION	
Course Name: Mathematical Physics (2) **Semester:** Second **Department: Physics** **Faculty: Science**	**Course Code: 0102282** **Section:** 1 **Core Curriculum**: Mathematical Physics
Day(s) and Time(s): Sunday: 10-11 Tuesday: 10-11 Thursday: 10-11 **Classroom:** AB 202	**Credit Hours:** 3 **Prerequisites**: Mathematical Physics (1)

COURSE DESCRIPTION

Second order differential equations, Sturm–Liouville problem, Lagrange's equations, Special functions: gamma function, beta function, error function, Legendre function, Laguerre function, Bessel function, Hermite function. Partial differential equations: in Cartesian, polar, and cylindrical coordinates. Integral transforms with applications. Laplace transforms. Fourier transforms. Green's functions. Functions of complex variables: Cauchy–Riemann condition. Residue theorem.

DELIVERY METHODS

The course will be delivered through

- A classroom lectures with active discussion
- E-learning resources: e-reading assignments through Microsoft Team

FACULTY INFORMATION

Name	**Mohamed Al-Sugheir**
Academic Title:	**Professor**
Office Location:	**Phy 203**
Telephone Number:	
Email Address:	**msugh@hu.edu.jo**
Office Hours:	Sunday: 11-12 Tuesday: 13-14 Thursday: 9-10 *Please send an e-mail msugh@hu.edu.jo to meet at any other time.*

REFERENCES AND LEARNING RESOURCES

Required Textbook:

1. "Special Functions for Scientists and Engineers", N. M. Laham and A. K. Abdallah", 3rd edition (3013).
2. "Mathematical Methods in the Physical Sciences", Mary L. Boas;" 3rd edition (2006).
3. "Mathematical Methods", M.C. Potter and Goldberg, 2nd edition (1987)
4. "Mathematical Methods for Physicists", G. Arfken, (1985)
5. "Mathematics in Physics and Engineers", J. Irving and N. Mullineux, (1966)
6. "Special Functions for Scientists and Engineers", W. W. Bell (1968).
7. "Mathematical Physics", E. Butkov, (1968).

STUDENT LEARNING OUTCOMES MATRIX*

Core Curriculum Learning Outcomes	Program Learning Outcomes	Course Objectives	Course Student Learning Outcomes	Assessment Method
Think critically and creatively in a variety of methods in order to make decisions and solve problems. Communicate proficiently with others. Identify the general concepts of humanities and natural sciences in a manner that reveals their value in life	Apply critical thinking and demonstrate problem-solving skills in many fields of physics. Use modern literature search methods to obtain information about physics topics and write reports. Communicate results to physicists and non-physicists.	1. Give the students at this level the mathematical techniques desperately needed for other physics courses. 2. Make those students familiar to the immediate application of these mathematical techniques. 3. Apply mathematical methods in solving physical problems.	1. Learn general method of solving second order differential equations 2. Learn the concepts behind the most general second differential equations. 3. Learn how to solve the Laplacian in cylindrical and spherical coordinates. 4. Define the special functions and to be apple to use them in some physical problems. 5. Identify the Legendre, Bessel, Lauguerre, Hermite functions and to use them.	• Exams • Quizzes • homework

ACADEMIC SUPPORT

It is The Hashemite University policy to provide educational opportunities that ensure fair, appropriate and reasonable accommodation to students who have disabilities that may affect their ability to participate in course activities or meet course requirements. Students with

disabilities are encouraged to contact their Instructor to ensure that their individual needs are met. The University through its Special Need section will exert all efforts to accommodate for individual's needs.

COURSE REGULATIONS

Participation

Class participation and attendance are important elements of every student's learning experience at The Hashemite University, and the student is expected to attend all classes. A student should not miss more than 15% of the classes during a semester. *Those exceeding this limit of 15% will receive a failing grade regardless of their performance*. It is a student's responsibility to monitor the frequency of their own absences. **Attendance record begins on the first day of class irrespective of the period allotted to drop/add and late registration. It is a student's responsibility to sign-in; failure to do so will result in a non-attendance being recorded.**

In exceptional cases, the student, with the instructor's prior permission, could be exempted from attending a class provided that the number of such occasions does not exceed the limit allowed by the University. The instructor will determine the acceptability of an absence for being absent. A student who misses more than 25% of classes and has a valid excuse for being absent will be allowed to withdraw from the course.

Plagiarism

Plagiarism is considered a serious academic offence and can result in your work losing marks or being failed. HU expects its students to adopt and abide by the highest standards of conduct in their interaction with their professors, peers, and the wider University community. As such, a student is expected not to engage in behaviours that compromise his/her own integrity as well as that of the Hashemite University.

Plagiarism includes the following examples and it applies to all student assignments or submitted work:

- **Use of the work, ideas, images or words of someone else without his/her permission or reference to them.**
- **Use of someone else's wording, name, phrase, sentence, paragraph or essay without using quotation marks.**
- **Misrepresentation of the sources that were used.**

The instructor has the right to fail the coursework or deduct marks where plagiarism is detected

Late or Missed Assignments

In all cases of assessment, students who fails to attend an exam, class project or deliver a presentation on the scheduled date without prior permission, and/or are unable to provide a medical note, will automatically receive a fail grade for this part of the assessment.

- Submitting a term paper on time is a key part of the assessment process. Students who fail to submit their work by the deadline specified will automatically receive a 10% penalty. Assignments handed in more than 24 hours late will receive a further 10% penalty. Each subsequent 24 hours will result in a further 10% penalty.
- In cases where a student misses an assessment on account of a medical reason or with prior permission; in line with University regulations an incomplete grade for the specific assessment will be awarded and an alternative assessment or extension can be arranged.

Student Complaints Policy

Students at The Hashemite University have the right to pursue complaints related to faculty, staff, and other students. The nature of the complaints may be either academic or non-academic. For more information about the policy and processes related to this policy, you may refer to the students' handbook.

COURSE ASSESSMENT

Course Calendar and Assessment

Students will be graded through the following means of assessment and their final grade will be calculated from the forms of assessment as listed below with their grade weighting taken into account. The criteria for grading are listed at the end of the syllabus

Assessment	Grade Weighting	Deadline Assessment
Exam 1	20%	
Exam 2	20%	
Quizzes	10%	
Homework	10%	
Final Exam	40%	

Description of Exams

Test questions will predominately come from material presented in the lectures. Semester exams will be conducted during the regularly scheduled lecture period.

Homework: Will be given for each chapter, while the chapter in progress you are supposed to work on them continuously and submit in next lecture when I finish the chapter.

Quizzes: Unannounced quizzes will be given during the semester based upon the previous lectures.

Grades are not negotiable and are awarded according to the following criteria*:

Letter Grade	Description	Grade Points
A+	Excellent	4.00
A		3.75
A-		3.50
B+	Very Good	3.25
B		3.00
B-		2.75
C+	Good	2.50
C		2.25
C-		2.00
D+	Pass	1.75
D	Pass	1.50
F	Fail	0.00
I	Incomplete	-

WEEKLY LECTURE SCHEDULE AND CONTENT DISTRIBUTION

"Lecture hours and weeks are approximate and may change as needed"

Chapter 2 Ref.1 Second Order Differential Equations	**Week 1&2**	**6 lecture**
1. Partial differential equations of mathematical physics 2. Ordinary differential equations. 3. Homogeneous linear second-order differential equations with variable coefficients. 4. Linear dependence and the Wronskian. 5. The second solution of the linear homogeneous second order differential equation. 6. Nonhomogeneous linear second order differential equation with variable coefficients. 7. Nonhomogeneous partial differential equations		
Chapter 3 Ref.1 Gamma and Beta Functions	**Week 3**	**3 lecture**
1. Gamma function 2. Beta function 3. Digamma function 4. Factorial function		
Chapter 4 *Ref.1* Sturm-Liouville Problem and Orthogonality of Function	**Week 4**	**3 lecture**
1. Generality of Sturm-Liouville problem 2. Hermitian operators 3. Completeness		

4. Bessel's inequality
5. Schwartz inequality
6. Gram-Schmidt orthogonality.
7. Green's functions for Sturm-Liouville operator

Chapter 5 Ref.1	Bessel Functions	**Week 5 &6**	**6 lecture hours**

1. Bessel's equation and Bessel function of the first kind
2. Bessel function of integral order.
3. Generating functions for Bessel functions
4. Orthogonality and normalization of Bessel functions
5. Neumann functions
6. Hankel functions
7. Modified Bessel functions
8. Spherical Bessel functions.
9. Orthogonality and normalization of spherical Bessel functions.

Chapter 6 Ref.1	Legendre Functions and Spherical Harmonics	**Week 7&8**	**6 lecture**

1. Legendre's equation
2. Legendre polynomial
3. Rodrigues Formula
4. Generating function for Legendre polynomials and physical basis for the generating function
5. Orthogonality, normalization, and completeness of Legendre polynomials.
6. Associate Legendre functions
7. Orthogonality and normalization of the associated Legendre functions
8. Spherical harmonics
9. Addition theorem for spherical harmonics.

Chapter 7 Ref.1	Hermite Functions	**Week 9&10**	**6 lecture**

1. Hermite polynomials
2. Generating functions
3. Rodrigues' formula for Hermite polynomials
4. Hermite's differential equation
5. Orthogonality and normalization of Hermite polynomials

Chapter 8 Ref.1	Laguerre Functions	**Week 11&12**	**6 lecture**

1. Laguerre polynomials
2. Generating functions
3. Rodrigues' formula for Laguerre polynomials
4. Laguerre's differential equation
5. Orthogonality of Laguerre polynomials
6. Associated Laguerre polynomials.
7. Orthogonality and normalization of associated Laguerre polynomials.

Chapter 14 Ref.2	**Functions of A Complex Variables**	**Week 13/14**	**4 lecture**

1. Analytic Functions
2. Contour Integrals and Cauchy Theorem
3. Laurent Series
4. The Residue Theorem:
5. Method of Finding Residues
6. Examples of Evaluating Integrals Using Residues

Ref.4	Integral Transforms	**Week 14-15**	**5 lecture hours**

1. The Laplace Transform
2. Applications of The Laplace Transform
3. Fourier Transforms
4. Applications of Fourier Transforms

ASSESSMENT RUBRICS

Assessment Rubrics to be determined by the department. Add samples below.

Classroom Participation: Assessment Criteria					
Criteria	**Quality**				**Score**
	Excellent (4 points)	**Good (3 points)**	**Satisfactory (2 points)**	**Needs Improvement (1 points)**	
Degree to which student integrates course readings into classroom participation	- often cites from readings; - uses readings to support points; - often articulates "fit" of readings with topic at hand.	-occasionally cites from readings; - sometimes uses readings to support points; -occasionally articulates "fit" of readings with topic at hand **.**	-rarely able to cite from readings; - rarely uses readings to support points; - rarely articulates "fit" of readings with topic at hand	-unable to cite from readings; -cannot use readings to support points; cannot articulates "fit" of readings with topic at hand .	
Interaction/ participation in classroom discussions	-always a willing participant, responds frequently to questions; - routinely volunteers point of view .	-often a willing participant, - responds occasionally to questions; - occasionally volunteers point of view .	-rarely a willing participant, - rarely able to respond to questions; - rarely volunteers point of view .	-never a willing participant., - never able to respond to questions; - never volunteers point of view .	
Interaction/ participation in classroom learning activities	-always a willing participant; -acts appropriately during all role plays; - responds frequently to questions; - routinely volunteers point of view.	-often a willing participant; -acts appropriately during role plays; - responds occasionally to questions; -occasionally volunteers point of view.	-rarely a willing participant. -occasionally acts inappropriately during role plays; - rarely able to respond to direct questions; -rarely volunteers point of view .	-never a willing participant - often acts inappropriately during role plays;, - never able to respond to direct questions; - never volunteers point of view.	
Demonstration of professional attitude and demeanor	-always demonstrates commitment through thorough preparation; - always arrives on time; - often solicits instructors' perspective outside class.	- rarely unprepared; rarely arrives late; - occasionally solicits instructors' perspective outside class **.**	-often unprepared; occasionally arrives late; - rarely solicits instructors' perspective outside class .	-rarely prepared; - often arrives late; -never solicits instructors' perspective outside class	

Classroom Participation: Oral Presentation										
Element	**Excellent**			**Satisfactory**			**Needs Improvement**			**Points**
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Organization	▪ There is a logical sequence of information. ▪ Title slide and closing slide are included appropriately.			▪ There is some logical sequence of information. ▪ Title slide and closing slides are included.			▪ There is little or no logical sequence of information. ▪ Title slide and/ or closing slides are not included.			
Slide Design (text, colors, background, illustrations, size, titles, subtitles)	▪ Presentation is attractive and appealing to viewers.			▪ Presentation is somewhat appealing to viewers.			▪ Little to no attempt has been made to make presentation appealing to viewers.			
Content	▪ Presentation covers topic completely and in depth. ▪ Information is clear, appropriate, and accurate.			▪ Presentation includes some essential information. ▪ Some information is somewhat confusing, incorrect, or flawed.			▪ Presentation includes little essential information. ▪ Information is confusing, inaccurate, or flawed.			
Language	▪ Spelling, grammar, usage, and punctuation are accurate ▪ Fluent and effective			▪ There are minor problems in spelling, grammar, usage, and/or punctuation.			▪ There are persistent errors in spelling, grammar, usage, and/or punctuation. ▪ Less or not fluent and effective.			
Delivery	▪ Ideas were communicated with enthusiasm, proper voice projection and clear delivery. ▪ There was sufficient eye contact with audience. ▪ There were sufficient use of other non-verbal communication skills. ▪ Appropriate delivery pace was used.			▪ There was some difficulty communicating ideas due to voice projection, lack of preparation, incomplete work, and/or insufficient eye contact. ▪ Insufficient use of non-verbal communication skills. ▪ Delivery pace is somewhat appropriate.			▪ There was great difficulty communicating ideas due to poor voice projection, lack of preparation, incomplete work, and/or little or no eye contact. ▪ No use of non verbal communication skills. ▪ Inappropriate delivery pace was used.			
Interaction with Audience	▪ Answers to questions are coherent and complete.			▪ Most answers to questions are coherent and complete.			▪ Answers to questions are neither coherent nor complete.			

	▪ Answers demonstrate confidence and extensive knowledge.	▪ Answers somehow demonstrate confidence and extensive knowledge.	▪ Is tentative or unclear in responses.	
	Total Score (Y x 5/16) =			

- ***يمكن اجراء التعديلات المناسبة حسب طبيعة المقرر وبالتنسيق مع الكلية المعنية وتحديد أنواع التعلم بوضوح (الكتروني، مدمج، وجاهي) ونماذج التعلم (نسبة التعلم الوجاهي الى الألكتروني ونسبة التعلم المتزامن الى غير المتزامن) التي سوف يتم اتباعها أثناء تدريس المساقات وبما يتوائم مع نسب الادماج المشار اليها في كتاب مجلس التعليم العالي رقم مع/1427. .***