هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA

2024
TP-153

Course Specification
(Bachelor)

Course Title:	**Computational Physics**
Course Code:	**PHY 1436**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	4
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: 2					
2. Course type					
A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		
3. Level/year at which this course is offered: (Level 7/ Year 4)					
4. Course General Description:					
Computers and computation are extremely important components of physics and should be integral parts of a physicist's education. Furthermore, computational physics is reshaping the way calculations are made in all areas of physics. This course covers the different types of computational problems using a programming language with exercises developed around problems of physical interest.					
5. Pre-requirements for this course (if any)**:**					
Computer application in physics, PHY 1335					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Learn and understand the basic knowledge of computational methods used in physics.**
- **Formulate a physical problem in a manner suitable for computational solution.**
- **Construct a working, structured program in programming language that includes standard numerical procedures to solve a physical problem.**
- **Employ appropriate numerical method to interpolate and extrapolate data collected from physics experiments.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid		

No	Mode of Instruction	Contact Hours	Percentage
	• Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	**0**
2.	**Laboratory/Studio**	**30**
3.	**Field**	
4.	**Tutorial**	**30**
5.	**Others (specify)**	**0**
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Outline the computational methods in solving problems in physics.**	**K1;K2**	• Supervision by lab instructor • Submitting an individual lab report. Performing lab. experiments at the scheduled times.	▪ Participation. ▪ Report evaluation. ▪ Lab experiment check. ▪ Exams.
1.2	**Describe and state the interpolation, extrapolation and data fitting, numerical ordinary and partial differential equations, numerical integration, and matrix algebra.**	**K1;K2**	• Supervision by lab instructor • Submitting an individual lab report. • Performing lab. experiments at the scheduled times.	▪ Discussion. ▪ Report evaluation. ▪ Lab experiment check. ▪ Exams.
1.3	**Implement numerical algorithms into MATLAB and visualize the results of the computations.**	**K1;K2**	• Supervision by lab instructor • Submitting an individual lab report.	▪ Participation. ▪ Report evaluation. ▪ Lab experiment check.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
			Performing lab. experiments at the scheduled times.	▪ Exams.
1.4	**Outline the computational methods in solving problems in physics.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.1	**Explain and summarize the basic knowledge gained from studying computational physics.**	**S1; S2**	• Using the multimedia and visual materials, Lab manual and the theoretical bases of the course. Interaction between students in the lab course community and discussions in the lab.	▪ Analyze experiments according to the plan besides the learning from lab lecture.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2; S3**	Experiments setting up, data recording and calculations based on lab manual and lectures (co-requisites).	▪ Explain and use information from the output of experiment to draw conclusions.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S3; S4**	• Experiments setting up, data recording and calculations based on lab manual and lectures (co-requisites).	▪ Summarize conclusions and write reports.
3.0	**Values, autonomy, and responsibility.**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction:** Overview - A Programming Language: Computer algorithms and languages, Using different software's, Applications: Newton and Kepler laws.	7
2.	**Finding roots of equations:** Bisection method- Newton's method- fixed point method, Algebraic and transcendental equations, Rearrangement of the equation.	8
3.	**Interpolation:** Polynomial interpolation, linear interpolation, quadratic interpolation, Lagrange interpolation, Newton difference method.	5
4.	**The method of least squares (Data Fitting)** Linear least squares; non-linear least squares.	5
5.	**Numerical Integration:** One dimensional integral: Rectangle rule; Trapezium rule; Simpson's rule; Gaussian integration.	6
6.	**Numerical solution of linear system (Matrix Algebra):** Simultaneous linear equations; Gaussian elimination; Pivoting, LU and cholesky.	5
7.	**Iterative method:** Jacobi, Gauss–Seidel iteration; convergence and matrix norm, tridiagonal matrices.	6
8.	**Numerical solution of Differential equations:** Difference equations; Euler and Picard methods; Taylor series solutions; System of equations, Runge– Kutta methods, Higher-order equations.	6
9.	**Finite differences method for ordinary differential equations**	6
10.	**Introduction to PDEs:** First order linear PDEs -Second order linear PDEs.	6
	Total	60

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**6th week**	**25 %**
3.	**Midterm Exam 2**	**12th week**	**25 %**

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
4.	Final Exam	16th week	40 %

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Chow T., Mathematical Methods for Physicists: A Concise Introduction, Cambridge University Press (2000).
Supportive References	-Pang Tao, An Introduction to Computational Physics, Cambridge University Press, (2006). -Richard Fitzpatrick, Computational Physics Texas University Press (2006).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	- Laboratory Manual supplied by the Department of Physics. Laboratory Manual is available at the website of the Department of Physics.

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **- Labs.**
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.** **- Software.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**- Students** **- Second examiner**	**- Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**- Instructors** -	**- Direct (exams, HW, project, ...)**

Assessment Areas/Issues	Assessor	Assessment Methods
Quality of learning resources	- Faculty - Students	- Indirect (surveys)
The extent to which CLOs have been achieved	- Instructors - Program Leaders	- Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024