# Physics 373 Intro to Computational Physics

Dr. Sabri Elatresh

Term 222: 2023



Physics 373 **Department of Physics** King Fahd University of **Petroleum & Minerals** 

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#### **Course Description:**

Computer Simulation of Physical systems. Topics covered: simulation techniques; programming methods; comparison of ideal and realistic systems; limitations of physical theory; behavior of physical systems.

**Pre-requisite:** PHYS 212 and ICS 101 (or 102 or 103)

Lecture Hours: UT (12:00-12:50)
LAB Hours: W (12:00-2:50 PM)

**Office Hours: UMT (01:00-1:50 PM)** 

**Textbook:** "Computational Physics: Problem Solving with Computers", by Landau, Paez & Bordeianu, Wiley (2012)".

#### **Supplementary Books:**

- (A)Numerical Analysis, Ninth Edition. Richard L. Burden and J. Douglas Faires
- (B)Python For Everyone, 2rd Edition, Cay S. Horstmann, Rance D. Necaise

#### **Grading Policy**

Grading Policy	%
Classwork Quizzes (10%) + LAB work (15%)	25
Projects	15
MidTerm Exam	30
Final Exam	30
Total	100

## **Attendance Policy:**

1. PHYS 373 course is offered in person. Class attendance and participation are required.

A DN grade shall be given to the student who has more than 12 unexcused absences in lectures.

### **Course Learning Outcomes PHYS-373**

On completion of the course, the student should be able to:

- Design and implement working Python code.
- Understand the basic principles of numerical methods and their application to solving physics problems.
- Be able to write computer programs to solve physics problems numerically.
- Be able to use numerical methods to model physical systems and analyze the results.
- Understand the limitations of numerical methods and the trade-offs between accuracy and computational time.
- Be able to critically evaluate the results of numerical simulations and compare them to analytical solutions and experimental data.
- Understand the importance of parallel computing and distributed computing in computational physics.
- Be familiar with the use of common programming languages and software packages used in computational physics.

1   15 Jan   Introduction to Computational Physics.   No Lab   Programs: Language and Structure   2   22 Jan   Error Analysis and Uncertainties   Programming with   python	Week	Date	Topics	Lab Assignment		
2   22 Jan   Error Analysis and Uncertainties   Programming with	1	15 Jan	Introduction to Computational Physics.	No Lab		
Taylor Theorem		19	Programs: Language and Structure			
Thursday - 26th Jan. 2023- Last day for dropping courses without permanent record   3   29 Jan   Bisection method   Secant method   Secant method   Taylor Theorem     4   05 Feb.   Numerical Roots of equations:   Root-Finding   Risection method     5   12 Feb   Systems of Linear Equations:   Root-Finding   Root-Finding     6   19 Feb.   Systems of Linear Equations:   Root-Finding   Newton-Raphson     6   19 Feb.   Systems of Linear Equations:   Gaussian   Systems of Linear Equations     7   26 Feb   Curve Fitting: Least Squares   Linear Regression   Nonlinear Problems     8   05 Mar.   Interpolation: Newton Polynomial Interpolation   Curve Fitting     9   12 Mar.   Numerical integration methods:   Trapezoidal rule   Simpson's rules   Monte Carlo     10   19 Mar   Ordinary Differential Equations:   Runge-Kutta Methods   Integration     11   26 Mar   Simpson's rules   Monte Carlo   Numerical   Integration     12   02 Apr   The Laplace and Poisson equations   PDE     12   02 Apr   The Laplace and Poisson equations   PDE     13   09 Apr   Quantum mechanical Calculations:   PDE (applications)     13   The Density-Functional Method (DFT)   Eid Al-Fitr Holidays: Apr. 14th - Apr. 27th 2023     14   30 Apr   Molecular Dynamics Simulation Method /   MD   Lsing model     Thursday - 04 May 2023: Last day for major exams; Last day for withdrawal from all courses with grade of "W"   No Lab	2	22 Jan	Error Analysis and Uncertainties	Programming with		
Solving Nonlinear Equations:   Bisection method   Secant method   Secant method   Taylor Theorem						
02 Feb.   Bisection method   Secant method   Taylor Theorem	Thurs	Thursday – 26th Jan. 2023- Last day for dropping courses without permanent record				
4 05 Feb. Numerical Roots of equations:	3					
Regula-Ealsi method   Newton-Raphson   (Bisection method)			'			
Social Systems of Linear Equations: Naive Gaussian Elimination   Newton-Raphson	4		•			
16		09		,		
6 19 Feb. Systems of Linear Equations: Gaussian Elimination   Algorithm for Tri-diagonal Equations  7 26 Feb O2 Mar Linear Regression   Nonlinear Problems  8 05 Mar. Interpolation: Newton Polynomial Interpolation Lagrange's interpolation:  9 12 Mar. Numerical integration methods: Interpolation 16 Trapezoidal rule   Simpson's rules   Monte Carlo  10 19 Mar Ordinary Differential Equations: Numerical integration 23 Runge-Kutta Methods integration  Midterm Exam: TBA  11 26 Mar Partial Differential Equation in Physics Augustant Pinite Difference algorithms for PDE  12 02 Apr The Laplace and Poisson equations PDE 12 02 Apr The Laplace and Poisson equations PDE 13 09 Apr Quantum mechanical Calculations: PDE (applications) 13 The Density-Functional Method (DFT)  Eid Al-Fitr Holidays: Apr. 14th - Apr. 27th 2023  14 30 Apr Molecular Dynamics Simulation Method / May Using model  Thursday - 04 May 2023: Last day for major exams; Last day for withdrawal from all courses with grade of "W"  15 07 May Presentations Presentations Polematics Sustainant Equations Polematics Equations Interpolations Curve Fitting Equations Equations  No Lab	5	12 Feb				
23		16	Naive Gaussian Elimination	Newton-Raphson		
Equations   Four Point   Four	6	19 Feb.				
7    26 Feb   Curve Fitting: Least Squares   Linear Regression   Nonlinear Problems     8		23		Equations		
12 Mar						
8 05 Mar. Interpolation: Newton Polynomial Interpolation	7			No Lab		
12 Mar.   Numerical integration methods:   Interpolation     16   Trapezoidal rule   Simpson's rules   Monte Carlo     10   19 Mar   Ordinary Differential Equations:   Numerical integration     23   Runge-Kutta Methods   integration						
9 12 Mar. Numerical integration methods: 16 Trapezoidal rule   Simpson's rules   Monte Carlo  10 19 Mar Ordinary Differential Equations: Runge-Kutta Methods  Midterm Exam: TBA  11 26 Mar Partial Differential Equation in Physics 30 Finite Difference algorithms for PDE  12 02 Apr Of The Laplace and Poisson equations 13 09 Apr Quantum mechanical Calculations: 14 10 Apr Density-Functional Method (DFT)  Eid Al-Fitr Holidays: Apr. 14th - Apr. 27th 2023  14 30 Apr Molecular Dynamics Simulation Method / MD   Ising model  Thursday - 04 May 2023: Last day for major exams; Last day for withdrawal from all courses with grade of "W"  15 07 May Presentations Presentations Presentations	8			Curve Fitting		
16						
10	9			Interpolation		
23   Runge-Kutta Methods   integration						
Midterm Exam: TBA  11	10					
11		23		integration		
30   Finite Difference algorithms for PDE	Midterm Exam: TBA					
30   Finite Difference algorithms for PDE	11	26 Mar	Partial Differential Equation in Physics	ODE		
13		30				
13	12	02 Apr	The Laplace and Poisson equations	PDE		
The Density-Functional Method (DFT)  Eid Al-Fitr Holidays: Apr. 14th - Apr. 27th 2023  14 30 Apr		06	Time-dependent Heat Equation			
13   The Density-Functional Method (DFT)   Eid Al-Fitr Holidays: Apr. 14th - Apr. 27th 2023     14   30 Apr	13	09 Apr	Quantum mechanical Calculations:	PDE (applications)		
14 30 Apr		_		, , ,		
O4 May   Ising model						
Thursday - 04 May 2023: Last day for major exams; Last day for withdrawal from all courses with grade of "W"  15 07 May Presentations No Lab Presentations	14	30 Apr	Molecular Dynamics Simulation Method /	MD   Ising model		
all courses with grade of "W"  15 07 May Presentations No Lab 11 Presentations		04 May	Ising model			
15 07 May Presentations No Lab Presentations	Thursday - 04 May 2023: Last day for major exams; Last day for withdrawal from all courses with grade of "W"					
11 Presentations	15	07 May		No Lab		
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		Final Exam: TBA				

## Physics 373 Lecture Schedule Spring 2023 (Term 222)