University of Management and Technology

School of Science (SSC)

Department of Physics

Course Code: PH-309
Course Title: Computational Physics
Program: BS (PH)

Course Outline (Spring 2019)

Lecture Schedule	Tuesday-Wednesday (02:00 – 03:15 PM)	**Pre-requisite**	Introduction to computing, Calculus, Mechanics
Course Instructor	Mr. H. Arslan Hashim	**Contact**	arslan.hashim@umt.edu.pk
Course Description	**Julia Programming:** Algorithms, Basic math with Julia and complex numbers, Arrays and matrix operations, Strings, Functions, Control flows, IO and plotting. Recipe of a simulation in Julia, GIF and Animation construction. **Errors** in numerical procedure. **Roots of equation**: Bisection, Regula-Falsi, Fixed-Point iteration, newton and secant method, iterative method. **Numerical methods for matrices:** Linear equation system, Eigen-value problem, Gauss-Elimination, Gauss-Jordan algorithms, special matrices and Iterative method. **Interpolation and Curve fitting:** Interpolation, Divided difference, Least-squares approximation. The Milikan experiment. **Numerical Calculus:** Numerical differentiation, Numerical Integration. **Ordinary differential equations:** Initial-value problems, the Euler and Picard methods. **A First Numerical Problem:** Radio decay, Programming guidelines. **Realistic Projectile Motion:** Bicycle Racing, Projectile motion, Throwing a Baseball: The effect of spin, Golf. **Oscillatory Motion and Chaos:** SHO, Physical Pendulum, Chaos in the Driven Nonlinear Pendulum and Lorenz model. **The Solar System**: Two-body problem: Earth and Sun, Three-body problem: Earth, Jupiter and Sun.		
Expected Outcomes	After successfully completing this course the student will: • be familiar with the basic Numerical techniques • Simulation methods with Examples • Ability to use these tools to model the problems in physics and other branches of science.		
Text Book	S. Nagar, "Beginning Julia Programming: For Engineers and Scientists", Apress, 2017. *Curtis F. Gerald, "Applied Numerical Analysis, 7th Ed. Pearson, 2004. **Nicholas J. Giordano, "Computational Physics", 2nd Ed. Pearson, 2006.		
Reference Books	Brain Bradie, A Friendly Introduction to Numerical Analysis, Pearson, 2001. T. Pang, "An introduction to Computational Physics", Cambridge University Press, 2008.		
Assignments	Problems will be assigned at regular intervals an assignment.	**Quizzes**	All quizzes will be announced well before time. No make-ups will be offered for missed quizzes.
Mid Term Examination	A 60-minutes exam will cover all the material covered during the first half of the semester.	**Final Examination**	A 120-minutes exam will cover all the material covered during the semester.
Attendance Policy	Students missing more than 20% of the lectures will receive an "SA" grade in the course and will not be allowed to take final exam.		

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Computational Physics

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Lecture Plan (Spring 2019)

Week	TOPICS	CH
1	**Julia-I:** Basic math with Julia and Complex Numbers, Arrays and matrix operations	3-8
2	**Julia-II:** Strings, Functions, Control flow, IO and plotting	9-13
3	**Error Analysis:** **Root Finding method:** Bisection method	*0 *1
4	Newton, Secant method Regula-Falsi, Fixed-Point method	*1 *1
5	**Numerical methods for matrices:** Vectors and Matrices, Linear equation system, Eigen-value problem, Gauss-Elimination method algorithm	*2 *2
6	Gauss-Jordan algorithm, Special matrices Inverse of a matrix, Iterative method.	*2 *2
7	**Program I: Simple algorithms (sum of series etc.)** **Interpolation and Curve Fitting:** Interpolating polynomial, Divided difference,	*3 *3
8	Least-Square polynomial **Numerical Calculus:** Numerical differentiation	*3 *5
9	Numerical Integration **A First Numerical Problem:** Radio Active Decay, Programming Guidelines	**1
10	**Simulation in Julia I** **Realistic Projectile Motion:** Bicycle racing,	**2
11	The effect of Air resistance. **Projectile motion with and without Air drag**	**2
12	**Simulation in Julia II** **Oscillatory motion and chaos: SHO, Simple Pendulum, Damped**	**3
13	**Programming II** **Driven and Physical Pendulum**	**3
14	**The Lorenz Model** **The Solar System: Two body problem**	**3 **4
15	**The Solar System: Three body problem**	**4