UNIVERSITY OF GHANA

DEPARTMENT OF COMPUTER SCIENCE
FIRST SEMESTER, 2018/2019
COURSE OUTLINE

Course Code: CSCD 207
Course Title: Numerical Methods
Credit Hours: Three (3)
Office Hours: By appointment

Days: Tuesday (@ 11:30) & Thursday (@ 07:30)
Lecturer: Solomon Mensah (PhD)
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Course Description:

CSCD 207: Numerical Methods are methods for solving problems on computers by numerical calculations, often giving a table of numbers and/or graphical representations or figures. Numerical methods tend to emphasize the implementation of algorithms. The aim of numerical methods is therefore to provide systematic methods for solving problems in a numerical form. The process of solving problems generally involves starting from an initial data, using high precision digital computers, following the steps in the algorithms, and finally obtaining the results. Often the numerical data and the methods used are approximate ones. Hence, the error in a computed result may be caused by the errors in the data, or the errors in the method or both.

Prerequisite: Calculus, Linear Algebra, C/ C++ programming

Recommended Textbooks and Resource Materials:

- **Atkinson, K.E.,** *An Introduction to Numerical Analysis, 2nd ed.,* Wiley, New York, NY, 1993.
- **Atkinson, K.E. and Han, W.,** *Elementary Numerical Analysis, 3rd ed.* Wiley, New York, 2004.
- **Atkinson, L.V. and Harley, P.J.,** *Introduction to Numerical Methods with PASCAL,* Addison Wesley, Reading, MA, 1984.
- **Atkinson, L.V., Harley, P.J. and Hudson, J.D.,** *Numerical Methods with FORTRAN 77,* Addison Wesley, Reading, MA, 1989.
- **Axelsson, K.,** *Iterative Solution Methods*, Cambridge University Press, Cambridge, UK, 1994.
- **Ayyub, B.M. and McCuen, R.H.,** *Numerical Methods for Engineers*, Prentice Hall, Upper Saddle River, NewJersey, NJ, 1996.
- **Chapra, S.C.,** *Applied Numerical Methods with MATLAB for Engineers and Scientists*, McGraw-Hill, NewYork, 2005.
- Other resource materials will be provided to students in electronic format.

Course Learning Outcomes:

Upon successful completion of this course, the student will be able to:

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyse and evaluate the accuracy of common numerical methods.

Methodology:

Lecture notes will be used for each class and will be made available to students. Using Lecture notes and class projects, students will be able to understand the core concepts and techniques pertaining to Numerical Methods. Students will be divided into various groups and end of course projects will be given them for presentations at the end of the course. Routine assignments comprising practical questions and reading assignments in the lecture notes will be given to students.

Lab Session Tools:

MATLAB (Student Version), R-Software, SPSS and MS Excel will be used for all Lab Assignments and Group Assessments. Students are expected to install the toolkits on their laptops for lab sessions.

Google Drive:

All students are requested to obtain a gmail account. All lecture materials will be made available in a shared folder on Google Drive. If you have any questions about the course or need assistance, please contact me in person during office hours or by e-mail at any time.

Grading Determination:

The final grade will be evaluated on the following basis:

- Interim Assessment (IA) 20%
- End of semester Exams 50%
- End of Course Project 25%
- Attendance 5%

Guidelines for Success:

- Come to class on time in every scheduled class meeting with materials needed to facilitate learning, such as the textbooks, notepads, pens, pencils and calculators.
- Take good notes.
- Read and understand the resource materials from the textbooks. If the material is not understood ask questions in class so the whole class can hear the answer.
- Complete and submit assignments when they are due, not later.
- Turn cell phones to "silent" during class and lab sessions.
- Eating or drinking is not allowed during lab sessions.

Tentative Course Outline*

Week	Class/Lab Session
1 & 2	• Introduction • Numerical Computations – Taylor's Series, Maclaurin's Series • Error Consideration – Absolute and Relative Errors, Inherent Errors, Round-off Errors, Truncation Errors • Stability and Condition Number
3	Linear system of equations – Direct Methods • Matrix Inverse Method • Cramer's Method • Gauss Elimination Method • Gauss-Jordan Method
4	Linear system of equations – Direct Methods (cont'd) • Cholesky's Triangularisation Method • Eigenvalues and Eigenvectors Linear system of equations – Indirect/Iterative Methods • Jacobi's Iteration Method • Gauss-Seidal Iteration Method • Assignment • Lab 1
5	Solution of Algebraic and Transcendental Equations • Bisection Method • Method of False Position (Regular Falsi Method) • Newton-Raphson Method (Newton's method)
6	Solution of Algebraic and Transcendental Equations (cont'd) • Successive Approximation Method • Secant Method

	• Assignment • Lab 2
7	• **Interim Assessment (IA)**
8	Finite Differences and Interpolation • Finite Difference Table • Newton's binomial expansion formula for equal intervals • Newton's forward interpolation formula for equal intervals • Newton's backward interpolation formula for equal intervals
9	Finite Differences and Interpolation (cont'd) • Central Difference Interpolation Formulae for equal intervals – Guass's Forward/ Backward Interpolation formulae • Lagrange's formula for unique (equal/unequal) intervals • Assignment
10	Numerical Integration • Trapezoidal rule • Simpson's 1/3 rule • Simpson's 3/8 rule
11	Numerical Integration (cont'd) • Boole's and Weddle's rules • Assignment Numerical Solution of Ordinary Differential Equation • Runge-Kutta Method of Order One • Euler – Cauchy (Modified Euler) Method • Lab 3
12	Numerical Solution of Ordinary Differential Equation (cont'd) • Runge-Kutta Method of Order Two • Runge-Kutta Method of Order Four • Assignment
13	Second Order Partial Differential Equation • Elliptic Equations • Parabolic Equations • Hyperbolic Equations • Assignment **Group Presentation**

***Subject to change during the quarter**

Policies:

Testing: Class Tests/Assignments are expected to be taken at the times scheduled, and make-up work will be permitted only for the following reasons:

- Death of an immediate family member
- Personal illness requiring attention by Physician
- Illness of an immediate family requiring your personal attention
- Unplanned holidays/ interruption by other College activities
- Travel out-of-town required by your employer (with proof)
- An emergency and/or situation at the discretion of the instructor

Attendance: Regular class attendance is expected. If a student misses class, the student is responsible for obtaining class notes from another student.