SYLLABUS:

Date / Revision 23 May 2015 / 02 May 2017 / PP
Faculty Life Sciences (LS)
Study Programs Biomedical Engineering (BME), Chemical Engineering (CHE), Food Technology (FTE)

SUBJECT: Numerical Methods

1 Basic Information

1.01	**Subject Name**	**Numerical Methods**
1.02	**Semester**	4
1.03	**Level**	*1*
1.04	**SKS**	2
1.05	**Mandatory / Curriculum**	*D-02*
1.06	**Subject Code**	NUME
1.07	**Subject Code**	BME-FTE-CHE-D-LS-117
1.08	**Year**	2017 (7)
1.09	**Quality Control**	Final Test, OFSE, see evaluation
1.10	**Limitations**	Min 12 and Max 32 students in one class
1.11	**Combined with**	All Faculty of Life Sciences Students
1.12	**Pre-requisite**	Engineering Mathermatics 1 & 2
1.13	**Responsible**	Dr. Tutun Nugraha
1.14	**Revision**	15-05-2017/pp

2 Description of Subject

This course is intended for 2nd year university students (4th semester) within the Faculty of Life Sciences. The students will learn the concept of errors and then capable of estimating its value. Several techniques tonumerically determine the roots of nonlinear equations are discussed, as well as the technique in solving the system of linear algebraic equations. Following this the students are then taught how to do regression and interpolation of a curve or a set of data. Furthermore, the techniques to integrate and differentiate the functions numerically are delivered. Finally, the students will learn how to numerically solve differential equations which often appear in engineering and science fields.

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3 Objectives

This course will equiped the students with various numerical methods to acquire solutions for various complex mathematical equations. This course will bridge the basic mathematical skills of the students that allow them to find numerical solutions manually to solving the more complex mathematical system that will require the use of computer programs to solve them

4 Competency

After having the course, students are expected to:

- Understand the concept of errors and calculate the errors.
- Able to determine the roots of nonlinear equations with several methods.
- Able to solve the system of linear algebraic equations.
- Understand the concept of optimization (constrained and unconstrained) as well as solve the problem of unconstrained optimization.
- Able to do regression and analyze it.
- Able to integrate and differentiate functions numerically.
- Able to solve ordinary differential equations (ODE) numerically.
- Able to solve partial differential equations (PDE) numerically.

5 Learning Approach / Methodology

- Lectures/ Class contact (time-tabled) supplemented with interactive questions and answers to build the projects;
- Tutorial/Laboratory/Practice Classes: preview of materials, revision and/or reports writing;
- Student Study Effort: homework/assignment; preparation for test/quizzes/ examination.
- Writing assignments/preseantations

6 Evaluation

5.1	**Absence maximum**	25%
5.2	**Participation in Discussion**	-
5.3	**Homework / Classwork**	20
5.4	**Presentation /Simulation**	-
5.5	**Daily Quiz**	20
5.6	**Final Examination**	60 Points
	Total	100 Points

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7 Text Book and Reference

1	**Main Text Book:** Numerical Methods for Engineers – S. C. Chapra and R. P. Canale – 6th Edition – McGraw-Hill Higher Education
2	**Supplemental Textbooks:** a) Numerical Methods for Chemical Engineers with Matlab Application – A. Constantinides and N. Mostoufi – Prentice Hall International Edition b) Numerical Methods for Chemical Engineering Application in Matlab – K. J. Beers – Cambridge University Press

8 Content / Topics of Lecture

Week	Content/ Topics of Lecturing	Text Book Chapter	Remark
1	**Introduction to Numerical Methods** Simple Mathematical Model, Conservation Laws, Several Computer Program in Numerical Methods	Homework/ Quiz	2 × 50 min
2	**Approximation of Error and Taylor Series** Significant Figures, Accuracy and Precision, Error Definition, Round-Off Errors, Taylor Series, Error Propagation, Total Numerical Errors	Homework/ Quiz	2 × 50 min
3	**Roots of Equations** Graphical Methods, Bisection Method, False-Position Method, Simple Fixed Point Iteration, Newton-Raphson Method	Homework/ Quiz	2 × 50 min
4	**Roots of Equations** Secant Method, Brent's Method, Linear Interpolation Method, Multiple Roots, Systems of Nonlinear Equations, Case Study	Homework/ Quiz	2 × 50 min
5	**Linear Algebraic Equations** Gaussian Elimination, Gauss-Jordan Elimination, LU Decomposition, Iterative Method, Gauss-Siedel, Case Study	Homework/ Quiz	2 × 50 min
6	**One-Dimensional Unconstrained Optimization** Golden-Section Search, Linear Interpolation, Parabolic Interpolation, Newton's Method, Brent's Method	Homework/ Quiz	2 × 50 min
7	**MultiDimensional Unconstrained Optimization** Direct Methods, Gradient Methods, Introduction to Constrained Optimization, Case Study	Homework/ Quiz	2 × 50 min
8	Midterm Break		
9	**Regression Analysis** Linear Regression, Polynomial Regression, Multiple Linear Regression, General Linear Least Square, Nonlinear Regression	Homework/ Quiz	2 × 50 min

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10	**Integration of Equations** Newton-Cotes Algorithm for Equations, Trapezoidal Method, Simpson Method, Romberg Integration, Adaptive Quadrature, Gauss Quadrature, Improper Integrals	Homework/ Quiz	2 × 50 min
11	**Numerical Differentiation** High-Accuracy Differentiation Formulas, Richardson Extrapolation, Derivatives of Unequally Spaced Data, Derivatives and integrals for Data with Errors, Partial Derivatives	Homework/ Quiz	2 × 50 min
12	**Ordinary Differential Equation (Runge-Kutta methods)** Euler's Method, Improvements of Euler's Method, Runge-Kutta Methods, Systems of Equations, Adaptive Runge-Kutta Methods	Homework/ Quiz	2 × 50 min
13	**Ordinary Differential Equation (Boundary-Value and Eigenvalue Problems)**Stiffness and Multistep Method, General Method for Boundary-Value Problems, Eigenvalue Problems, Case Study	Homework/ Quiz	2 × 50 min
14	**Partial Differential Equation (Finite Difference : Elliptic Equations)** The Laplace Equation, Solution Technique, Boundary Conditions, The Control-Volume Approach	Homework/ Quiz	2 × 50 min
15	**Partial Differential Equation (Finite Difference : Parabolic Equations)** The Heat-Conduction Equation, Explicit Methods, A Simple Implicit Method, The Crank-Nicolson Method	Homework/ Quiz	1 x 1 x 50 minutes
16, 17	**Final Examination**		

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