TEMPLATE FOR COURSE SPECIFICATION (Numerical Analysis)

HIGHER EDUCATION PERFORMANCE REVIEW: PROGRAMME REVIEW

COURSE SPECIFICATION

Engineers depend on mathematical equations to describe behavior of many physical systems. In practice these equations cannot be solved analytically, therefore, numerical methods are often used. This course introduces engineering students to a variety of numerical methods and algorithms. This course introduces students to: Error analysis; Finding roots of a non-linear function; Approximation and interpolation; Numerical integration and differentiation; direct and indirect solution of systems of linear equations; Solution of nonlinear systems; solving ordinary differential equations and partial differential equations. Survey of numerical methods for solving problems commonly encountered in heat and mass transfer, fluid mechanics, and chemical reaction engineering.

1. Teaching Institution	University of Technology
2. University Department/Centre	Chemical Engineering Department
3.Course title/code	Numerical Analysis /332
4.Programme(s) to which it contributes	CE.332
5.Modesof Attendance offered	Full time
6.Semester/Year	1 semester/year
7. Number of hour stuition(total)	5
8. Date of production/revision of this Specification	2016/6/7
9. Aims of the Course	
1) To study numerical analysis methods and their applications in chemical engineering.	
2) To solve chemical engineering problems with numerical analysis techniques.	
3) To learn the basics of MATLAB and to write simple MATLAB codes.	

10·LearningOutcomes, Teaching, Learning and Assessment Method

A-Knowledge and Understanding

A1) Understand the numerical solution of nonlinear equations.
A2) Understand the numerical solution of simultaneous linear algebraic equations.
A3) Understand the basic of finite difference methods and interpolation.
A4) Understand the numerical differentiation and integration.
A5) Understand the numerical solution of ordinary differential equations.
A6) Understand the numerical solution of partial differential equations.

B-Subject-specific skills

B1) Implement numerical methods illustrated using Matlab.
B2) Solve chemical engineering problems numerically using Matlab.

Teaching and Learning Methods

Lectures: Two hours lectures per week will be given to students.
Tutorials: one hour per week.
Laboratories: Two hours per week.
Case Study: Some practical case studies will be given during the course.
Assignments: One assignment will be given by the end of each lecture.

C. Thinking Skills

An ability to create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations

Teaching and Learning Methods

Lectures, Tutorials, Example Classes, Weekly homework problems, Practical Applications, Special problems.

Assessment methods

Midterm exams, Final exam, Quizzes, Weekly homework, weekly Laboratory exam, report of solving special problems.

D. **General and Transferable Skills (other skills relevant to employ ability and personal development).**

Dl) Discuss and work in a group in order to solve numerical approximation problems.
D2) Discuss and work in a group in order to program numerical solutions using Matlab.
D3) Demonstrate developed solutions and programs.

11.Course Structure

Week	Hours	ILOs	Unit/Moduleor Topic Title	Teaching Method	Assessment Method
1st semester					
1	3	Provide an understanding of types of error in computation	Fundamentals of MATLAB Programming, Numerical Solution, type of errors; relative error, absolute error, percentage error, truncation error, round off error. Floating	Lectures, Practical Applications	partial test (Oral questions :- multiple choice)
2	3	Provide an understanding how to solve nonlinear equations	Solving non-linear equations using:- 1)Bisection method, 2)Secant method 3) Newton-Raphson method	Lectures , Example Classes , Practical Applications	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , or do not have a definite
3	3	Provide an understanding how to find multi roots of polynomial equation	Finding Roots of polynomials using:- 1)Newton-Raphson method 2)Grapical method	Lectures, Tutorials , Example Classes , Practical Applications	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
4	3	Provide an understanding how to make Interpolation	Lagrangian Polynomials, Divided differences, Cubic spline interpolating	Lectures, Tutorials , Example Classes , Practical Applications	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
5	3	Provide an understanding how to represent multiple points in polynomial equation	Polynomial approximation using:- polynomials, Newton's forward and backward difference formulas.	Lectures, Tutorials , Example Classes , Practical Applications	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
6	3	Provide an understanding how to predict derivatives from multi points	Forward, backward and central difference approximation of the derivatives, Higher Order Derivatives, Differentiating Tabulated Function	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)

7	3	understanding the basics of numerical integration	Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules.	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
8	3	understanding numerical integration of double integrals	Double integrals using trapezoidal and Simpson's rules.	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
9	3	Understanding solving a system of linear equations by direct and indirect methods	Solution of linear system of equations by direct methods (Gaussian elimination and Gauss-Jordon). Solution of linear system of equations by Iterative methods (Gauss-Seidel and Jacobi).	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
10	3	Understanding solving a system of non-linear equations.	Solution of non-linear system of equations by Newton-raphson method.	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
11	3	Understanding how to solve ordinary differential equation.	Initial value problems. Solution of first-order ordinary differential equations using Taylor's method, Eular method, Modified Euler’s method, Runge-Kutta method(2nd, 3rd and 4th order methods)	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
12	3	Understanding how to solve a system of simultaneous ordinary differential equation.	Solution of simultaneous ordinary differential equations:- Eular method, Runge-Kutta methods	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
13	3	Understand the Types of Partial Differential Equations:	Types of Partial Differential Equations: Elliptic (Poisson) equation, Parabolic (heat) equation, Hyperbolic (wave) equation.	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)

14	3	Understand solving Partial Differential Equations	Finite difference solution of Partial Differential Equations. Numerical solution of partial differential equations using explicit, implicit and Crank-Nicolson methods elliptic (Laplace) equation	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)
15	3	Understand solving chemical engineering problems of Partial Differential Equations	Heat balance in two dimension, unsteady state Diffusion in two dimension	Lectures, Tutorials , Example Classes , Weekly homework problems	Exams , Weekly homework, Team and homework problems , Open questions that have a definite answer , (Oral questions)

12.Infrastructure	
Required reading: ·CORETEXTS ·COURSEMATERIALS ·OTHER	**Lecturers** **Book -References** 1. "Numerical Methods for Engineers",Steven C. Chapra, Raymond P. Canale, McGraw Hill, 6th edition, 2010. **Other support books :-** 1. Methods for Engineers and Scientists", Joe Hoffman, McGraw-Hill Book Company,1993. 2. "Applied Numerical Methods with MATLAB for Engineers and Scientists", 2nd Edition, by S. Chapra. 3. "Applied Numerical Analysis", Gerald,C.F. and Wheatley, P.O., 6th Edition, Pearson Education, 2006. 4. "Numerical Methods for Chemical Engineers With MATLAB Applications", Alkis Constantinides, Navid Mostoufi, Prentice Hall, 1999.
Special requirements(include for example workshops, periodicals, IT software, websites)	Websites , Laboratory
Community-based facilities (include for example, guest Lectures, internship, field studies)	guest Lectures

13. Admissions	
Pre-requisites	Basic principles of chemical engineering, Computer programming using Matlab 2012a, Engineering
Minimum number of students	35
Maximum number of students	50