

# GUJARAT TECHNOLOGICAL UNIVERSITY

## CHEMICAL (COMPUTER AIDED PROCESS DESIGN) (16)

Mathematical and Statistical methods in Chemical Engineering

SUBJECT CODE: 3711611

SEMESTER: I

**Type of course: Program Elective - I**

**Prerequisite:** Instrumentation and Process Control

**Rationale:** In this subject emphasis is given on Computerised process control, leading finally to application in chemical process plants. The first part of this subject deals with Automation and computer interface. The second part gives highlights on Feedback and Advanced Control systems. The third part includes its application in the field of chemical engineering like liquid level systems, heat exchanger etc.

**Teaching and Examination Scheme :**

| Teaching Scheme |   |   | Credits | Examination Marks |        |                 |        | Total Marks |  |
|-----------------|---|---|---------|-------------------|--------|-----------------|--------|-------------|--|
| L               | T | P |         | Theory Marks      |        | Practical Marks |        |             |  |
|                 |   |   |         | ESE(E)            | PA (M) | PA (V)          | PA (I) |             |  |
| 3               | 0 | 0 | 3       | 70                | 30     | 0               | 0      | 100         |  |

### Content

| Sl. No. | Topic  | Teaching Hours | Module Weightage (%) |
|---------|--|----------------|----------------------|
| 1       | Interpretation of Engineering Data:<br>Classification of measurements, Types of Errors, Significant figures, Accuracy of Numbers, Precision, Error Propagation Variance and Distribution of Random Errors.   | 5              | 10                   |
| 2       | Solution of Non Linear Algebraic Equations:<br>Basic properties of equations, Bisection method, Method of False Position, Secant method, Mullers method, Newton-Raphson Method, Comparison of methods.   | 6              | 10                   |
| 3       | Solution of Linear Algebraic Equations:<br>Cramers rule, Matrix inversion, Gauss Elimination, Gauss-Jordan Method, Gauss-Seidel Iteration Method, Factorization method, Ill-conditioned equations, Comparison of methods.  | 6              | 10                   |
| 4       | Empirical Laws & Curve Fitting:<br>Method of Least Squares, Fitting of linear equation, Fitting of non-linear equation, Method of group averages, Method of moments.   | 5              | 10                   |
| 5       | Finite differences and Interpolation:<br>Forward, backward and central difference formula.<br>Newtons forward and backward interpolation formula, Gauss's forward and backward interpolation formula, Lagranges interpolation formula, Spline Interpolation, Cubic Spline. | 6              | 10                   |

|   |  |    |     |
|---|--|----|-----|
| 6 | Numerical Integration:<br>Newton-Cotes Integration Formulas, Trapezoidal Rule and Simpson's Rules, Gaussian integration  | 5  | 10  |
| 7 | Ordinary Differential Equations :<br>Euler's Method, Modifications and Improvements in Euler's Method. Runge-Kutta Methods, Boundary Value Problems, Shooting method.  | 6  | 10  |
| 8 | Partial Differential Equations:<br>Solution of Parabolic, Hyperbolic, Elliptic equations, Solution of Laplace and Poissons equation.   | 5  | 10  |
| 9 | Probability and Statistics:<br>Probability Distributions, Random Variables, Sampling Distributions, Population Means, Confidence Interval, Stochastic Processes, Standard Deviation, Sampling distributions and tests of significance, Analysis of variance, Bayes' theorem and Bayesian statistics, | 10 | 20  |
|   | <b>Total</b>   | 54 | 100 |

### Reference Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Publication.
2. Numerical Methods for Engineers, S C Chapra and R P Canale, McGraw Hill Publication.
3. Applied Mathematics in Chemical Engineering, Mickley, Sherwood, Reed, McGraw Hill Publication
4. Numerical Methods in Engineering & Science, B. S. Grewal, Khanna Publishers.
5. Numerical Methods for Scientific and Engineering Computation, M K Jain, S R K Iyengar and R K Jain, New Age International Publishers.
6. Applied Statistics and Probability for Engineers, Montgomery and Runger, John Wiley & Sons.
7. Numerical Method for Engineers, Santosh Gupta, New Age International Publishers.

### Course Outcome:

After learning the course the students should be able to:

1. Solve different mathematical problems through effective application of various mathematical and statistical methods.
2. Solve rigorous process models in fluid flow, mass transfer, heat transfer and other allied areas of chemical engineering using effective application of mathematical methods.
3. Efficiently plan experiments, collect data, analyze and interpret the data, and understand how the observed data are related to the proposed model for the problem under study.

### List of Open Source Software/learning website:

1. Students can refer to video lectures available on the websites including NPTEL lecture series.
2. Students can refer to the CDs available with some reference books for the solution of problems using softwares/spreadsheets. Students can develop their own programs/spreadsheets for the solution of problems.