# Advanced Mathematical Techniques in Chemical Engineering - Video course

## COURSE OUTLINE

1. Introduction of vector space;Metric, Norm, Inner Product space;Examples
2. Onto, into, one to one function, completeness of space
3. Vectors: Linear combination of vectors, dependent/independent vectors; Orthogonal and orthonormal vectors; Gram-Schmidt orthogonalization; Examples
4. Contraction Mapping: Definition; Applications in Chemical Engineering; Examples
5. Matrix, determinants and properties
6. Eigenvalue Problem:Various theorems; Solution of a set of algebraic equations; Solution of a set of ordinary differential equations; Solution of a set of non-homogeneous first order ordinary differential equations (IVPs)
7. Applications of eigenvalue problems: Stability analysis; Bifurcation theory; Examples
8. Partial Differential equations:Classification of equations; Boundary conditions;Principle of Linear superposition
9. Special ODEs and Adjoint operators:Properties of adjoint operator; Theorem for eigenvalues and eigenfunctions;
10. Solution of linear, homogeneous PDEs by separation of variables: Cartesian coordinate system & different classes of PDEs; Cylindrical coordinate system ; Spherical Coordinate system
11. Solution of non-homogeneous PDEs by Green's theorem
12. Solution of PDEs by Similarity solution method
13. Solution of PDEs by Integral method
14. Solution of PDEs by Laplace transformation
15. Solution of PDEs by Fourier transformation

## COURSE DETAIL

| S.No | Topics | Lectures |
|---|---|---|
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NP-TEL

NPTEL

**http://nptel.iitm.ac.in**

Chemical Engineering

**Pre-requisites:**

- Chemical Process Calculation
- Reaction Engineering

**Coordinators:**

**Prof. S. De**
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|---|---|---|
| 1 | Introduction of vector space Metric, Norm, Inner Product space Examples | 7 |
| 2 | Onto, into, one to one function, completeness of space | 1 |
| 3 | Vectors<br>• Linear combination of vectors, dependent/independent vectors<br>• Orthogonal and orthonormal vectors<br>• Gram-Schmidt orthogonalization<br>• Examples | 3 |
| 4 | Contraction Mapping<br>• Definition<br>• Applications in Chemical Engineering<br>• Gram-Schmidt orthogonalization<br>• Examples | 3 |
| 5 | Matrix, determinants and properties | 2 |
| 6 | Eigenvalue Problem<br>• Various theorems<br>• Solution of a set of algebraic equations<br>• Solution of a set of ordinary differential equations<br>• Solution of a set of non-homogeneous first order ordinary differential equations (IVPs) | 4 |
| 7 | Applications of eigenvalue problems<br>• Stability analysis<br>• Bifurcation theory<br>• Examples | 3 |
| 8 | Partial Differential equations<br>• Classification of equations<br>• Boundary conditions<br>• Principle of Linear superposition | 2 |
| 9 | Special ODEs and Adjoint operators<br>• Properties of adjoint operator<br>• Theorem for eigenvalues and | 3 |

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|---|---|---|
| | eigenfunctions | |
| 10 | Solution of linear, homogeneous PDEs by separation of variables<br>• Cartesian coordinate system & different classes of PDEs<br>• Cylindrical coordinate system<br>• Spherical Coordinate system | 8 |
| 11 | Solution of non-homogeneous PDEs by Green's theorem | 5 |
| 12 | Solution of PDEs by Similarity solution method | 2 |
| 13 | Solution of PDEs by Integral method | 1 |
| 14 | Solution of PDEs by Laplace transformation | 2 |
| 15 | Solution of PDEs by Fourier transformation | 2 |

**References:**


1. Mathematical Methods in Chemical Engineering by S. Pushpavanam, Prentice Hall of India.
2. Applied Mathematics and Modeling for Chemical Engineers by R. G. Rice & D. D. Do, Wiley.
3. Mathematical Method in Chemical Engineering by A. Varma & M. Morbidelli, Oxford University Press.
4. Applied Mathematical Methods for Chemical Engineers by N. W. Loney, CRC Press.