Course Code	Course Name	Credits
MEDLO5013	**Computational Methods**	**03**

Objectives:

1. Introduction to analytical and numerical techniques.
2. Application of mathematical modelling to mechanical systems.
3. Learn the significance of statistical techniques and data interpolation.

Outcomes: Learner will be able to…

1. Understand and develop mathematical models of physical systems.
2. Identify an appropriate mathematical formulation to linear algebraic equations.
3. Build an appropriate mathematical formulation to non-linear algebraic equations.
4. Evaluate and interpret the data regression, curve fitting and statistics.
5. Apply the numerical techniques and numerical schemes.
6. Formulate the concept of numerical methods in realistic applications.

Module	Details	Hrs
1	**Introduction to Computational Methods** Motivation and applications of Computational Methods. Computation and Error Analysis:Accuracy and precision; Truncation andround-off errors (Numericals); Binary Number System; Error propagation.	06
2	**Linear Systems and Equations** Matrix representation: Cramer's rule; Gauss Elimination. Matrix Inversion: LUDecomposition; Iterative Methods;Relaxation Methods; Eigen Values and Eigen Vectors.	06
3	**Non Linear Algebraic Equations:** Bracketing methods: Bisection, Regula-Falsi. Crouts Method: LU Decomposition. Open methods: Secant, Fixed pointiteration, Newton-Raphson; MultivariateNewton's method.	06
4	**Regression and Curve Fitting** Interpolation function; Cubic Splines; Multi regression analysis, polynomial regression. **Statistical methods:** Statistical representation of data, modeling and analysis of data, test of hypotheses. **Fuzzy Logic:** Introduction to fuzzy logic, Fuzzy Logic Systems Architecture, Case study of Mechanical system.	08
5	**Integration and Integral Equations** Newton Cotes Quadrature **ODEs: Initial Value Problems** Euler's methods; Predictor-corrector method (Adam's Moulton, Milne's Method) **ODEs: Boundary Value Problems** Finite difference Method; Finite Element Method, Finite Volume Method	07

6	**Application of Numerical Methods** Predict vibration response of components to intricate profile generated by different machine tools, Design next generation Formula One cars to working at the cutting edge of robotics, Predict behaviour of flows to estimation of heat transfer in complex scenarios; Crank Nicolson method – Solution of 1-D Wave equation.	**06**

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then
4. part (b) will be from any module other than module 3)
5. Only **Four questions need to be solved**.

Text/Reference Books:

1. S. P. Venkateshan& Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books Pvt. Ltd., 1st Edition, (2014) ISBN: 978-0-12-416702-5.
2. Steven C. Chapra& Raymond P.Canale, "Numerical Methods for Engineers", Mc-Graw Hill Education, 8TH Edition, (2020), ISBN: 1260571386
3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001) ISBN: 0-8247-0443-6.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, 2019.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fifth Edition, 2012.
6. Rajesh Kumar Gupta, Numerical Methods – Fundamentals and Applications, Cambridge University Press, First Edition, 2019.
7. Gupta and Santosh K., "Numerical Methods for Engineers", 4th Edition, New Age International Publishers, 2019, ISBN: 9789387788794
8. FerzigerJ.and M. Peric, "Computational Methods for Fluid Dynamics" 3rd Edition, Springer, (2001) ISBN: 9783540420743.
9. Versteeg H., and W. Malalasekra,"An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, PHI(2007) ISBN: 9780131274983.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/127/106/127106019/ - Numerical Methods for Engineers, IIT Madras
https://nptel.ac.in/courses/111/107/111107105/ - Numerical Methods, IIT Roorkee
https://nptel.ac.in/courses/111/106/111106101/ - Numerical Analysis, IIT Madras
https://nptel.ac.in/courses/111/107/111107107/ - Numerical Methods: Finite Difference Approach, IIT Roorkee