Course Handout

Institute/School Name	Chitkara University Institute of Engineering & Technology		
Department Name	Department of Computer Science & Engineering		
Programme Name	Bachelor of Engineering- Computer Science & Engineering (Artificial Intelligence)		
Course Name	Computer Oriented Numerical Techniques	Session	2024-2025
Course Code	24APS2102	Semester/Batch	2nd/2024
L-T-P(Per Week)	4-0-0	Course Credits	4
Pre-requisite	Basic concepts upto +2 level and introduction to the course content	NHEQF Level	4.5
Course Coordinator	Dr. Inderpreet Kaur	SDG Number	4,9

Objectives of the Course

Computer-Based Numerical Techniques (CBNT) are used to optimize performance and minimize error in the problem solving applications. This is an area of mathematics and computer science that teaches the learners to create, analyse, and implement algorithms for obtaining numerical solutions to problems involving continuous variables. The development of computer software to implement numerical algorithms is an important part of the subject.

The main objectives of this course are:

- To impart an intuitive and working insight of numerical methods for the basic problems of numerical analysis.
- To encourage the learners to solve these problems through an optimized computer code via minimization of the error using any high-level language.

Course Learning Outcomes (CLOs)

Student should be able to:

	CLOs	Program Outcomes (PO)	NHEQF Level Descriptor	No. of Lectures
CLO01	Understand the term "Numerical Error", source of error and analyse its impact on multiple numerical computations and its usage in evaluating the efficiency of computer algorithms.	PO1, PO2, PO3, PO4, PO5, PO11, PO12	Q1, Q2	4
CLO02	To learns various nu numerical techniques to solve real-life mathematical problems.	PO1, PO2, PO3, PO4, PO5, PO11, PO12	Q3	17
CLO03	To create algorithms for implementing the numerical techniques and check the performance of such algorithms.	PO1, PO2, PO3, PO4, PO5, PO11, PO12	Q2, Q3	13
CLO04	Understand differential equations and their practical usage in the real life problems.	PO1, PO2, PO3, PO4, PO5, PO11, PO12	Q1, Q2	18
Total Contact Hours				52

CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	Type of Assessment's
CLO 01	H	H	L	M	L						L	H	H	M	H	Formative Summative
CLO 02	H	H	M	H	L						L	H	H		M	Formative Summative
CLO 03	M	H	M	H	M						L	M	M		M	Formative Summative
CLO 04	L	M	M	M	L						L	L	M		L	Formative Summative

CLO-PO Mapping

H=High, M=Medium, L=Low

Recommended Books:

B01: Computer Oriented Numerical Methods, R. S. Salaria, Khanna Book Publishing Co. (P.) Ltd., New Delhi; 6th Edition.
B02: An Introduction to Numerical Methods and Analysis, F. E. James, Wiley-Blackwell, 2nd Edition.
B03: Computer Oriented Numerical Methods, P. Thangaraj, PHI learning, 1st Edition.
B04: Computer Oriented Statistical and Numerical Methods, E. Balaguruswamy, Laxmi Publications, 1st Edition.
B05: Computer Oriented Numerical Methods, V Rajaraman, PHI Learning, 4th Edition.
B06: Numerical Methods for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar, R. K. Jain, New Age International Publishers, 7th Edition.
B07: An Introduction to Numerical Analysis, K. E. Atkinson, John Wiley & Sons, 2nd Edition.
B08: Numerical Methods in Engineering & Science, B. S. Grewal, Khanna Publishers, 3rd Edition.
B09: Introductory Methods of Numerical Analysis, S. S. Sastry, PHI, 4th Edition.

Other readings and relevant websites:

Serial No	Link of Journals, Magazines, websites and Research Papers
1.	https://onlinecourses.nptel.ac.in/noc21_ma45/preview
2.	https://onlinecourses.nptel.ac.in/noc20_ge20/preview
3.	https://numericalmethodstutorials.readthedocs.io/en/latest/
4.	https://onlinecourses.nptel.ac.in/noc21_ma45/preview
5.	https://onlinecourses.nptel.ac.in/noc20_ge20/preview
6.	https://numericalmethodstutorials.readthedocs.io/en/latest/
7.	https://www.youtube.com/watch?v=0NsRloi4xd4

Recommended Tools and Platforms

Python, C/C++, MATLAB

Course Plan: Theory+ Lab Theory Plan

Lecture Number	Topics
1	**Prerequisite:** Basic concepts up to +2 level and introduction to the course content.
2	**Errors and Approximations:** Introduction to Errors, Sources of Error, Types of errors: Truncation errors, Round off errors, Computational errors.
3	Significant digits, Measures of accuracy: Absolute errors, Relative errors, Percentage errors.
4	**Solution of algebraic and transcendental equations**: Numerical solutions, Types of non-linear equations: Polynomial equations, Transcendental equations.
5-6	**Iterative methods**, Bisection method, Regula Falsi method, Termination criteria.
7-8	Secant method, Newton Raphson method.
9	Accuracy, Rate and order of convergence of iterative methods.
10	**Interpolation:** Finite difference, Forward, Backward and Central difference, Difference of a polynomial.
11-12	Newton's formulae for interpolation: Newton forward and backward interpolation.
13-14	Central difference interpolation formulae: Bessel's and Sterling formula.
15	Interpolation with unevenly spaced points, Lagrange's Interpolation.
16-17	**Numerical differentiation:** Numerical differentiation using Newton forward and backward method only , Maximum and Minimum values of a tabulated function.
18-20	**Numerical Integration**- Newton-cotes integration formulae, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule.
21	Gaussian Quadrature Formula.
ST-1 (Syllabus covered from Lecture 1 to 21)	
22-25	**Numerical solution of ordinary differential equations**: Initial Value Problems for Ordinary Differential Equations: Single step methods: – Picard's method of successive approximations,

	Euler and modified Euler methods, Taylor Series method.
26-27	Fourth order R-K method for solving first and second order equations.
28-29	Multi-Step method, Milne's and Adam's predictor and corrector methods.
30-32	**Curve Fitting**: Cubic splines and approximation: Introduction, least square curve fitting, procedures -fitting a straight line.
33-35	Nonlinear curve fitting.
36-38	Curve fitting by a sum of exponentials, $y=ae^{bx}$, $y=ax^{b}$.
39-41	Data fitting with cubic splines-derivation of governing equation, end conditions.
ST-2 (Syllabus covered from Lecture 22 to 41)	
42-45	**Numerical solution of partial differential equations:** Classification of linear partial differential equation of second order, Finite difference approximation to derivatives.
46-47	Solution to Laplace's equation- Jacobi's method, Gauss -Siedel method.
48	Solution of Poisson equation.
48-50	Parabolic equation and their solution using iterative methods: Bender-Schmidt method, Crank-Nicolson.
51	S.O.R method.
52	Hyperbolic partial differential equation, explicit finite difference method.
END TERM – FULL SYLLABUS	

Delivery/Instructional Resources Theory Plan:

Lect. No.	Topics	**CLO**	**Book No, CH No, Page No**	**TLM**	**ALM**	**Web References**	**Audio-Video**
1-3	Prerequisite: Basic concepts upto +2 level and introduction to the course content. Errors and Approximations: Introduction to errors, Sources of error, Types of errors: Truncation errors, Round off errors, Computational errors, Significant digits ,Measures of accuracy: Absolute errors, Relative errors, Percentage errors.	CLO01	B06, CH 1, Page no 1-9 B07, CH 1, Page no 3-17	Lecture	Think/pair /share Quiz/Test Questions	http://home.iitk.ac.in/~pranab/ESO208/rajesh/03-04/Errors.pdf http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000025MS/P001476/M014241/ET/1456308539E-textofChapter1Module1.pdf	https://www.youtube.com/watch?v=fROf2j2SoYQ

4-6	Solution of algebraic and transcendental equations: Numerical solutions, Types of non-linear equations : Polynomial equations, Transcendental equations, Iterative Method, Bisection method, Regula Falsi method, Termination criteria.	CLO01	B06, CH 2, Page no 17-102 B08, CH 2 Page no 19-43	Lecture	Quiz/ Test Questions	http://nitkkr.ac.in/docs/15-%20Solutions%20of%20Algebric%20and%20Transcendental%20Equations.pdf	https://www.youtube.com/watch?v=3j0c_FhOt5U
7-9	Secant method, Newton Raphson method, Accuracy, Rate and order of convergence of iterative methods.	CLO01 , CLO02	B06, CH 2, Page no 17- 102 B08, CH 2 Page no 47-63	Lecture	Quiz/ test Questions	http://homepage.math.uiowa.edu/~whan/3800.d/S3-3.pdf http://iosrjen.org/Papers/vol4_issue4%20(part-1)/A04410107.pdf	https://slideplayer.com/slide/3248315/
10-12	Interpolation: Finite difference, Forward, Backward and Central difference, Difference of a polynomial Newton's formulae for interpolation: Newton forward and backward interpolation.	CLO02	B06, CH 4, Page no 210-313 B08, CH 7 Page no 273-286	Lecture	Quiz/ test Questions	https://www.lkouniv.ac.in/site/writereaddata/siteContent/2020040322505719 12siddharth_bhatt_engg_Interpolation.pdf https://www.geeksforgeeks.org/newton-forward-backward-interpolation/	https://www.youtube.com/watch?v=OreSw2zPW-g
13-15	Central difference interpolation formulae: Bessel's and Sterling formula spaced points, Lagrange's Interpolation.	CLO02	B06, CH 4, Page no 210-313 B08, CH 7 Page no 289-290	Lecture	Quiz/ test Questions	https://atozmath.com/example/CONM/NumeInterPola.aspx?he=e&q=SM	https://www.youtube.com/watch?v=rCZIb9ue98Q
16-17	Numerical differentiation: Numerical differentiation using Newton forward and backward method only , Maximum and Minimum values of a tabulated function.	CLO02	B06, CH 5, Page no 320-343 B08, CH 8 Page no 339-352	Lecture	Quiz/ test Questions	https://theengineeringmaths.com/wp-content/uploads/2017/11/num-diff-integ-web.pdf	https://www.youtube.com/watch?v=ziRui_LFo3E

18-20	Numerical Integration-Newton-cotes integration formulae, Trapezoidal rule, Simpson1/3 rule, Simpson's 3/8 rule.	CLO02, CLO03	B07, CH 5 Page no 251-260 B08, CH 8 Page no 358	Lecture	Quiz/ test Questions	https://www3.nd.edu/~zxu2/acms40390F15/Lec-4.3.pdf	https://www.youtube.com/watch?v=3Lcz5bg3GOg
21	Gaussian Quadrature formula.	CLO02, CLO03	B07, CH 5 Page no 269-270	Lecture	Quiz/ test Questions	https://www3.nd.edu/~zxu2/acms40390F15/Lec-4.7.pdf	https://www.youtube.com/watch?v=3Lcz5bg3GOg
22-25	Numerical solution of ordinary differential equations: Initial Value Problems for Ordinary Differential Equations: Single step methods:– Picard's Method of successive approximations, Euler and Modified Euler methods, Taylor Series method.	CLO04	B08, CH 10 Page no 420-432	Lecture	Quiz/ test Questions	https://www.lkouniv.ac.in/site/writereaddata/siteContent/20200403225057206868siddharth_bhatt_engg_Numerical_Solution_of_Ordinary_Differential_Equations.pdf	**https://slideplayer.com/slide/5296614/**
26-27	Fourth order R-K method for solving first and second order equations.	CLO03	B08, CH 10 Page no 438-440	Lecture	Quiz/ test Questions	https://www.lkouniv.ac.in/site/writereaddata/siteContent/20200403225057206868siddharth_bhatt_engg_Numerical_Solution_of_Ordinary_Differential_Equations.pdf	**https://slideplayer.com/slide/5296614/**
28-29	Multi-Step method, Milne's and Adam's predictor and corrector methods.	CLO03, CLO04	B08, CH 10 Page no 448-456	Lecture	Quiz/ test Questions	https://en.wikiversity.org/wiki/Adams-Bashforth_and_Adams-Moulton_methods	**https://slideplayer.com/slide/5296614/**
30-38	Curve Fitting: Cubic splines and approximation: Introduction, Least square curve fitting ,Procedures -fitting a straight line, Nonlinear curve fitting, Curve fitting by a sum of exponentials, $y=ae^{bx}$, $y=ax^{b}$.	CLO01, CLO04	B08, CH 7 Page no 326-329, CH 5 194-216	Lecture	Quiz/ test Questions	http://sites.iiserpune.ac.in/~bhasbapat/phy221_files/curvefitting.pdf	**https://slideplayer.com/slide/5296614/**
39-41	Data fitting with cubic splines-derivation of governing equation, end conditions.	CLO03	B08, CH 5 Page no 200-216	Lecture	Quiz/ test Questions	https://www.math.ucla.edu/~baker/149.1.02w/handouts/dd_splines.pdf	**https://www.youtube.com/watch?v=gT7F3TWihvk**

42-45	Numerical solution of Partial differential equations: Classification of linear partial differential equation of second order, Finite difference approximation to derivatives.	CLO04	B08, CH 11 Page no 491-494	Lecture	Quiz/ test Questions	http://www.ehu.eus/aitor/irakas/fin/apuntes/pde.pdf	**https://www.youtube.com/watch?v=gT7F3TWihvk**
46-48	Solution to Laplace's equation- Jacobi's method, Gauss -Siedel method, Solution of Poisson equation.	CLO04	B08, CH 11 Page no 495-508	Lecture	Quiz/ test Questions	http://www.ehu.eus/aitor/irakas/fin/apuntes/pde.pdf	**https://www.youtube.com/watch?v=gT7F3TWihvk**
48-50	Parabolic equation and their solution using iterative methods: Bender-Schmidt method, Crank-Nicolson.	CLO04	B08, CH 11 Page no 521-530 B09 CH-8 Page no 339-360	Lecture	Quiz/ test Questions	https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/2018/NM-Unit-V.pdf	**https://www.youtube.com/watch?v=m_1ohMonnOU**
51	S.O.R method.	CLO04	B09 CH-8 Page no 339-360	Lecture	Quiz/ test Questions	https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/2018/NM-Unit-V.pdf	**https://www.youtube.com/watch?v=Rd5Fevrk5MY**
52	Hyperbolic partial differential equation, Explicit Finite difference method.	CLO04	B08, CH 11 Page no 535 B09 CH-8 Page no 339-360	Lecture	Quiz/ test Questions	https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/2018/NM-Unit-V.pdf	**https://www.youtube.com/watch?v=q8uKEQIEPQk** **https://www.youtube.com/watch?v=zcW_UHmaCKA**

Remedial Classes

After every Sessional Test, different types of learners will be identified and special discussions will be planned and scheduled accordingly.

Action Plan for different types of learners:

Learner Type-I	Learner Type- II	Learner Type- III
Remedial Classes, Doubt Sessions, Guided Tutorials	Workshop, Doubt Session	Projects, Coding Competitions

Self-Learning

Assignments to promote self-learning, survey of contents from multiple sources.

S. No	Topics	CLO	ALM	References/MOOCS
1	Newton Raphson Method	CLO01, CLO02	Think/pair/share	https://pythonnumericalmethods.studentorg.berkeley.edu/notebooks/chapter19.04-Newton-Raphson-Method.html

2	Numerical Differentiation and Integration	CLO03, CLO04	Think/pair/share	https://www.mathworks.com/help/matlab/numerical-integration-and-differentiation.html

Delivery Details of Content Beyond Syllabus

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.No	Advanced Topics, Additional Reading, Research papers and any	CLO	POs	ALM	References/MOOCS
1	Numerical Solution of Integral Equations	CLO04	PO1,PO2, PO3, PO11	Think/Pair/Share	http://library.uc.edu.kh/userfiles/pdf/8.Numerical%20Solution%20of%20Integral%20Equations.pdf

Evaluation Scheme & Components:

Assessment Type	Evaluation Component	Type of Component	No. of Assessments	% Weightage of Component	Max. Marks	Mode of Assessment	CLO
Summative	Component 1	Sessional Tests (STs)	02*	40%	30	Offline	CLO01, CLO02, CLO03, CLO04
Summative	Component 2	End Term	01**	60%	60	Offline	CLO01, CLO02, CLO03, CLO04,
	Total		**100%**				

**. All STs are mandatory. Average of both ST's should be taken for the internal assessment.*

*** To appear for the End Term Exam, attendance must be 75% or more.*

Syllabus of the Course:

SNo.	Topic (s)	No. of Lectures	Weightage %
1-3	**Prerequisite:** Basic concepts up to +2 level and introduction to the course content. **Errors and Approximations:** Introduction to errors, Sources of error, Types of errors: Truncation errors, Round off errors, Computational errors, Significant digits, Measures of accuracy: Absolute errors, Relative errors, Percentage errors.	3	5%
4-9	**Solution of algebraic and transcendental equations**: Numerical solutions, Types of non-linear equations: Polynomial equation, Transcendental equation. **Iterative methods**, Bisection method, Regula Falsi method, Termination criteria, Secant method, Newton Raphson method, Accuracy, Rate and order of convergence of iterative methods.	6	12%
10-15	**Interpolation:** Finite difference, Forward, Backward and Central difference, Difference of a polynomial Newton's formulae for interpolation: Newton forward and backward interpolation, Central difference interpolation formulae: Bessel's and Sterling formula spaced points, Lagrange's Interpolation.	6	12%

16-17	**Numerical differentiation:** Numerical differentiation using Newton forward and backward method only, Maximum and Minimum values of a tabulated function.	2	3%
18-21	**Numerical Integration**- Newton-cotes integration formulae, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule Gaussian Quadrature formula.	4	8%
22-29	**Numerical solution of ordinary differential equations**: Initial Value Problems for Ordinary Differential equations: Single step methods: – Picard's method of successive approximations, Euler and Modified Euler methods, Taylor Series method, Solution of simultaneous equations, Second order equation, Fourth order R-K method for solving first and second order equations Multi-Step method, Milne's and Adam's predictor and corrector methods.	8	15%
30-41	**Curve Fitting**: Cubic splines and approximation: Introduction, Least square curve fitting, Procedures -fitting a straight line, Nonlinear curve fitting, Curve fitting by a sum of exponentials, $y=ae^{bx}$, $y=ax^{b}$ Data fitting with cubic splines-derivation of governing equation, end conditions.	12	23%
42-52	**Numerical solution of partial differential equations:** Classification of linear partial differential equation of second order, Finite difference approximation to derivatives, Solution to Laplace's equation- Jacobi's method, Gauss -Siedel method, Solution of Poisson equation Parabolic equation and their solution using iterative methods: Bender-Schmidt method, Crank-Nicolson, S.O.R method, Hyperbolic partial differential equation, Explicit finite difference method.	11	22%

Academic Integrity Policy:

Education at Chitkara University builds on the principle that excellence requires freedom where Honesty and integrity are its prerequisites. Academic honesty in the advancement of knowledge requires that all students and Faculty respect the integrity of one another's work and recognize the importance of acknowledging and safeguarding intellectual property. Any breach of the same will be tantamount to severe academic penalties.

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Inderpreet Kaur	
Program In charge	Dr. Reetu Malhotra	
Dean	Dr. Mohit Kumar Kakkar	
Date (DD/MM/YYYY)	10/1/2025	