PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Course Code				**23MAMAL232**			
Title of the Course				**NUMERICAL METHODS**			
Offered to:				**B.Sc. Hons (Mathematics)**			
L	**5**	**T**	**1**	**P**	**0**	**C**	**4**
Year of Introduction:		**2024-25**		**Semester:**			**3**
Course Category:		**MAJOR**		**Course Relates to:**		**GLOBAL**	
Year of Revision:		**NA**		**Percentage:**		**NA**	
Type of the Course:				**SKILL DEVELOPMENT**			
Crosscutting Issues of the Course :				**NA**			
Pre-requisites, if any				**Basics of Advanced calculus and Differential equations**			

Course Description:

This course is a basic course offered to UG student of Engineering/ Science background. It contains Interpolation, Numerical differentiation, and curve fitting. It plays an important role for solving various Engineering Sciences problems. Therefore, it has tremendous applications in diverse fields in engineering sciences.

Course Aims and Objectives:

S.NO	COURSE OBJECTIVES
1	Define the Basic concepts of operators Δ, ∇ , E and solving symbolic relations.
2	Apply numerical methods with equal intervals and unequal intervals to find out solution of algebraic equations using different methods under different conditions .
3	Apply various central difference interpolation methods to find out the solutions of the given functions.
4	Able to Calculate the value of the derivative of a function at some assigned value using different methods.
5	Improve the accuracy and reliability of a model or system by reducing the error between the data output.

Course Outcomes

At the end of the course, the student will be able to…

CO NO	COURSE OUTCOME	BTL	PO	PSO
CO1	Understand concepts of operators and relation between the operators.	K2	7	1
CO2	Calculate the value of a function using interpolation.	K5	7	2
CO3	Define the Basic concepts of operators μ,δ and solve problems using central difference formulas.	K2	2	1
CO4	Find derivatives using various numerical methods.	K3	1	2
CO5	Fit polynomials to given set of points.	K5	7	2

For BTL: K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

CO-PO MATRIX									
CO NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1	2							2	
CO2	3								3
CO3		2						2	
CO4	2								3
CO5		2							2

Course Structure:

UNIT-I: THE CALCULUS OF FINITE DIFFERENCES

The operators Δ, ∇, E, Fundamental theorem of difference calculus, properties of Δ, ∇,E and problems on them to express any value of the function in terms of the leading terms and the leading differences , relations between E and D, relation between D and Δ, Problems on one or more missing terms, Factorial notation, Problems on separation of symbols, Problems on Factorial notation.

Examples/Applications/Case Studies:

1. Explain fundamental theorem of difference calculus.
2. Find the factorial form of a given function.
3. Find the missing terms of the given data using fundamental theorem.

Exercises:

1. Show that the operators Δ and E are commutative.
2. Evaluate $\Delta^n\sin(ax+b)$.
3. Construct the forward difference table for the given data.

Web Resources:

http://spartan.ac.brocku.ca/~jvrbik/MATH2P20/notes.pdf

UNIT-II: INTERPOLATION WITH EQUAL AND UNEQUAL INTERVALS

Derivations of Newton Gregory Forward and Backward interpolation and problems on them, Divided differences, Newton divided difference formula and problems, Lagrange's interpolation formula and problems.

Description: Interpolation is a method in numerical analysis that estimates intermediate values of a function based on aset of known data points. It can be used in engineering and science to estimate the value of a function for values of the indepent variables that are not explicitly given in the data .

Examples/Applications/Case Studies:

1. Find the approximate value of f(x) for the given data using suitable interpolation formula..
2. Using the Newton's divided difference formula, find a polynomial function for the given data.
3. By Lagranges interpolation formula find the value of y at some x for the given data.

Exercises:

1. Derive the Newton's forward interpolation formula for equal intervals.
2. State and prove the Newton's divided difference formula for unequal intervals.
3. Derive Legranges interpolation formula.

Web Resources:

https://archive.nptel.ac.in/courses/111/107/111107062/

UNIT-III: CENTRAL DIFFERENCE INTERPOLATION FORMULA

Central difference operators δ, μ, σ and relation between them, Gauss's Forward interpolation formulae, Gauss's backward interpolation formulae, Stirling's formula, Bessel's formula and problems on the above formulae.

Description: The central differnce interpolation formulais statistical method in numerical analysis that uses unknown values to model complicated functions and estimate unknown values.

Examples/Applications/Case Studies:

1. Apply any suitable central difference formula to approximate rhe value of the function y for the given data.
2. Use Gauss's interpolation formula to find y at some x with the help of given data.

3. Explain any realation between central difference operators.

Exercises:

1. Derive the Gauss's forward central difference formula.
2. State and prove Stirling's central difference formula.
3. Derive Bessel's formula.

Web Resources:

https://math.iitm.ac.in/public_html/sryedida/caimna/interpolation/cdf.html

UNIT-IV: NUMERICAL DIFFERENTIATION

Derivatives using Newton's forward difference formula, Newton's back ward difference formula, Derivatives using central difference formula, Stirling's interpolation formula, Newton's divided difference formula.

Description: Numerical differentiation is the process of finding the numerical value of a derivative of a given function at a given point. In business differentiation is used to find profit and loss for the future of investiment using graphs.Temparature variations are also calculated by using differentiation.

Examples/Applications/Case Studies:

1. Calculate the highest and lowest point of a curve in a graph.
2. Compute the first and second derivative of a function f from given values of f.

Exercises:

1. Derive the formulas for first derivative and second derivative using Newton's back ward formula.
2. Find the approximate value of second derivative using give set of paired values.

Web Resources:

https://archive.nptel.ac.in/content/storage2/courses/122104018/node117.html

UNIT-V: CURVE FITTING

Method of least squares, Fitting of a straight line, Non linear curve fitting, curve fitting by a sum of exponentials.

Description: Curve fitting is a process that involves finding a function or curve that best fits a set of data points. The curve fitting process can involve constraints on the data points. The goal is to find a function that minimizes the residual or distance between the data points and the function. A smaller residual means a better fit.

Examples/Applications/Case Studies:

1. To find the path of roller coaster, the turning point of a railway track, paths of a road particularly in hilly areas.
2. Used to estimate variable values between data samples and outside the data sample range.

Exercises:

1. Fit a straight line for the given paired values by the method of least squares technique.
2. Fit a second degree parabola for the given data.

Web Resources:

https://perhuaman.files.wordpress.com/2014/07/metodos-numericos.pdf

Text Books :

1. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Pvt. Ltd., NewDelhi-110001, 2006.
2. Dr.A. Anjaneyulu, A Text Book of Mathematics, Advanced Numerical Analysis, Deepthi Publications, Tenali

Reference Books:

1. Dr.A. Anjaneyulu, A Text Book of Mathematics, Numerical Analysis, Deepthi Publications, Tenali.
2. P. Kandasamy, K. Thilagavathy, Calculus of Finite Differences and Numerical Analysis. S. Chand & Company, Pvt. Ltd., Ram Nagar, New Delhi-110055.
3. S. Ranganatham, Dr.M.V.S.S.N. Prasad, Dr.V. Ramesh Babu, Numerical Analysis, S. Chand &Company Pvt. Ltd., Ram Nagar, New Delhi-110055.

***

PARVATHANENI BRAHMAYYA SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Autonomous

Siddhartha Nagar, Vijayawada–520010

Re-accredited at 'A+' by the NAAC

Course Code /Title of the Course: **23MAMAL232 : Numerical Methods**

Offered to: B.Sc.Hons.Mathematics

Time: 3Hrs **Max Marks:** 70M

<u>Model Paper</u>

SECTION – A

I Answer the following Questions **5 x 4 = 20M**

1. (a) Construct the forward difference table for the following data

x	1	2	3	4	5
F(x)	7	12	29	64	123

(CO1, K3)

(OR)

(b) Express $f(x) = x^4 - 4x^3 + 7x^2 + 3x - 6$ in terms of the factorial notation. (CO1, K3)

2. (a) Use Lagranges interpolation formula to find the form of the function from the data

x	0	3	4
F(x)	12	6	8

(CO2, K1)

(OR)

(b) Construct the Newton' divided difference table for the given data:

x	1	2	7	8
F(x)	1	5	5	4

(CO2, K1)

3. (a) Prove that $\sqrt{1+\delta^2 u^2} = 1+\frac{1}{2}\delta^2$ (CO3, K5)

(OR)

(b) Derive Bessel's formula. (CO3, K5)

4. (a) Write Newton's forward difference formula to find $\frac{dy}{dx}$ at $x = x_0$.(CO4,K3)

(OR)

(b) Using the given table find $\frac{dy}{dx}$ at x = 2.03 (CO4,K3)

x	1.96	1.98	2.00	2.02	2.04
y	0.7825	0.7739	0.7651	0.7563	0.7473

5(a) Fit a polynomial of the second degree to the data points

x	0	1	2
y	1	6	17

(CO5,K4)

(OR)

(b) By the method of least squares fit a straight line to the following data

x	1	2	3	4	5
y	14	27	40	55	68

(CO5,K4)

SECTION – B

II Answer the following **5 x 10 = 50M**

6. (a) State and Prove fundamental theorem of difference calculus. (CO1,K5)

(OR)

(b) Obtain the missing terms from the following data: (CO1,K5)

x	1	2	3	4	5	6	7	8
f(x)	1	8	?	64	?	216	343	512

7. (a) State and Prove Newton Gregory Forward interpolation formula. (CO2,K5)

(OR)

b) State and Prove Lagrange's Interpolation formula. (CO2 ,K5)

8. (a) State and prove Gauss's forward interpolation formula. (CO3,K5)

(OR)

(b) Apply Bessel's formula to find the value of f (27.4) from the table (CO3,K5)

x:	25	26	27	28	29	30
f(x):	4.000	3`846	3.704	3.571	3.448	3.333

9. (a) Using the given table find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at x = 1.2

x	1.0	1.2	1.4	1.6	1.8	2.0	2.2
y	2.7183	3.3201	4.0552	4.9530	6.0496	7.3891	9.0250

(CO4, K2)

(OR)

(b) Derive the formulas of $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ using Newtons backward interpolation formula. (CO4, K2)

10. (a) Fit a power curve $y = ae^{bx}$ by the method of least squares

x	0.5	1	1.5	2	2.5
y	0.45	2.15	9.15	40.35	180.75

(CO5,K5)

(OR)

(b) Fit a curve $y = ax^b$ by the method of least squares using the following table (CO5,K5)

x	61	26	7	2.6
y	350	400	500	600

***