PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

[2022-23 EVEN/ WINTER SEMESTER]

COURSE HAND OUT [Integrated Course]

SCHOOL: SOE **DEPT: MATHEMATICS** **DATE OF ISSUE: 16/02/2023**

NAME OF THE PROGRAM : B. Tech

P.R.C. APPROVAL REF. : PU / AC18.10 / MAT08 / MAT2003

(Applicable to B. Tech all branches, IV semester SOE, SoCSE)

SEMESTER/YEAR : IV semester / 2nd year [2022-2023]

COURSE TITLE & CODE : Numerical Methods for Engineers (MAT2003)

COURSE CREDIT STRUCTURE : 1-2-2

CONTACT HOURS : 3 periods per week

COURSE IC : Dr. Nagendramma V and Dr. Kavita Permi

COURSE INSTRUCTOR(S) : Dr. Nagendramma V, Dr. Kavita Permi, Dr. Shilpa N, Dr. Rajeshwari M, Dr. Pradeep Kumar, Dr. Sandeep Kumar, Dr. Bhavya K, Dr. Jagan K, Dr. Veeresha A S, Dr. A. Jasmine Benazir, Dr. Gopi R, Dr. Meenakshi Shivhare , Dr. Nagaraja B, Dr. Vijaylaxmi S B, Dr. Mobeen Ahmad, Dr. Naveenkumar S H, Dr. Mohammad Javed Alam, Dr. Nazir Ahmad Ahengar, Dr. Ashish Kumar Prasad, Dr. C Muralidaran, Dr. Hussain Basha, Dr. Felicita Almeida, Dr. M. Manikandan, Dr. Manasi K Sahukar, Dr. Karthick G.

COURSE URL : https://www.camu.in/index#/staffhome

PROGRAM OUTCOMES :

PO 01. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems. [H]

PO 02. Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences. [M]

PO 03. Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 04. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. [L]

PO 05. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 06. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO 07. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 08. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 09. Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
PO 10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions. [L]
PO 11. Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.
PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE PREREQUISITES: Knowledge of system of equations, differentiation, integration and differential equations.

COURSE DESCRIPTION: The course focuses on formulating and solving problems concerning real-world engineering applications numerically as well as statistically. This course provides an introduction to basic numerical methods to deal with algebraic and transcendental equations, system of equations, interpolation, differentiation and integration. This course also deals with numerical solution of ordinary differential equations by means of Taylor's series method, modified Euler's method and Runge-Kutta methods**.** The lab sessions associated with the course are concerned with acquiring an ability to use the MATLAB software.

COURSE OUTCOMES: On successful completion of the course the students shall be able to:

TABLE 1: COURSE OUTCOMES

CO Number	CO	Expected BLOOMS LEVEL
1	Solve algebraic and transcendental equations numerically.	Application
2	Use numerical techniques to differentiate and integrate functions.	Application
3	Apply numerical methods to solve ordinary differential equations.	Application

MAPPING OF C.O. WITH P.O. [Mark H/M/L Against each of the C.O. depending on the degree of contribution of the C.O.to the P.O.]

[H-HIGH , M- MODERATE, L-LOW]

TABLE 2: CO PO Mapping ARTICULATION MATRIX

CO. No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13
CO1	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**
CO2	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**
CO3	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**-**

COURSE CONTENT (SYLLABUS):

Module 1: Numerical solution of Algebraic and Transcendental Equations [5 sessions] [Application]

System of Linear Equations: Introduction, LU decomposition method, Gauss-Seidel iteration method. Algebraic and Transcendental Equations: Newton-Raphson method, secant method.

Module 2: Numerical Interpolation, differentiation and Integration [5 sessions] [Application]

Numerical Interpolation: Newton's method, divided difference method, Lagrange's method, numerical differentiation. Numerical integration: Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth rule.

Module 3: Numerical solution of ODEs and PDEs [5 sessions] [Application]

Solution of ordinary differential equations: Modified Euler's method, 4^{th} order Runge-Kutta method. Solution of partial differential equations: Forward, Central and Backward differences - Crank-Nicolson method.

DELIVERY PROCEDURE (PEDAGOGY): The instructor guides the students through the course material in 45 lectures. Application problems are discussed at the end of each module. Review classes are conducted periodically to encourage and reinforce learning. Assessment practices enable robust and fair judgments about students performance.

TABLE 3: SPECIAL DELIVERY METHOD/ PEDAGOGY PLANNED WITH TOPICS				
S. No	**Lecture Number**	**Subtopic as per lesson Plan**	**Pedagogy title/ short explanation of adopted pedagogy**	**** At end of semester please update whether activity was done**
1	**L4**	LU decomposition method	Peer learning	
2	**L11**	Simpson's three-eighth rule.	Group based problem solving	

REFERENCE MATERIALS:

Text Books

T1: M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computations, 6th Edition, New age Publishing House, 2015.
T2: Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley& Sons (India), 2014.

Reference Books

R1: B.S. Grewal, Numerical methods in engineering and science, 10th Edition, Khanna publishers, 2016.
R2: Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers," 7th Ed., McGraw-Hill Edition, 2015.
R3: C. Ray Wylie and Louis C Barrett, "Advanced Engineering Mathematics", 6th Edition, McGraw-Hill, 2012.
R4: B.S. Grewal, "Higher Engineering Mathematics", 44th edition, Khanna Publishers.
R5: MATLAB usage manual.

E-Resources (https://presiuniv.knimbus.com)

1. https://directory.doabooks.org/handle/20.500.12854/40207
2. https://directory.doabooks.org/handle/20.500.12854/54913
3. https://directory.doabooks.org/handle/20.500.12854/54918

Web Resources

1. https://www.pdfdrive.com/numerical-methods-for-engineers-and-scientists-using-matlab-e167411070.html
2. https://www.pdfdrive.com/advanced-numerical-methods-with-matlab-2-resolution-of-nonlinear-differential-and-partial-differential-equations-e176451171.html
2. https://www.pdfdrive.com/numerical-methods-for-ordinary-differential-equations-e187199027.html

Video Lectures

1. https://www.youtube.com/watch?v=QqhSmdkqgjQ&ab_channel=nptelhrd
2. https://nptel.ac.in/courses/127106019
3. https://archive.nptel.ac.in/courses/111/107/111107105/

SPECIFIC GUIDELINES TO STUDENTS: (Here mention a few tips to study this course effectively)

1. Be regular to the classes. Refer to the material given by the instructor.
2. More practice on problems discussed in the class is taken care of through exercise problems.
3. Calculators is compulsory for all classes; hence students need scientific calculator.
4. The objective of the assignment is to solve/understand/relate real-time problems with mathematical concepts.
5. Students should come prepared with the basics of the topics that will be covered in the next class.
6. Make-up exams as per academic regulations. There is no make-up for quiz and assignment.
7. Chamber consultation hour will be announced in class.
8. All notices concerning the course will be displayed on the department and class notice boards. It will also be communicated to the class representative.

COURSE SCHEDULE FOR LABORATORY COMPONENT:

TABLE 4.1: COURSE BROAD SCHEDULE FOR LABORATORY COMPONENT

Sl. No.	ACTIVITY	PLANNED STARTING DATE	PLANNED CONCLUDING DATE	TOTAL NUMBER OF PERIODS
01	Over View of the course	16/2/23	17/2/23	2
02	Laboratory Familiarization	20/2/23	3/3/23	4
03	Demonstration of first set of Experiments/Skills	6/3/23	10/3/23	2
04	Conduct of first set of experiments	13/3/23	11/4/23	10
05	Conduct of second set of experiments	17/4/23	19/5/23	10
06	Summary of the Laboratory tasks	22/5/23	2/6/23	2

DETAILED SCHEDULE OF INSTRUCTION:

SELF LEARNING COMPONENT: Newton's interpolating polynomial sample, Program to implement Crank-Nicolson method.

MAIN PEDAGOGY: Power Point Presentation and Lecture.

TABLE 5.1: DETAILED LAB SCHEDULE/ LESSON PLAN				
Session Number	**Task**	**Number of Lab Sessions required to complete the task**	**Skills to be developed**	**Course Outcome Number**
P1	Getting started with MATLAB	1	Ability to understand MATLAB software	
P2	Basic inbuilt functions in MATLAB	1	Ability to understand basic inbuilt functions in MATLAB	
P3	Basic loop control statements in MATLAB	1	Ability to understand basic loop control statements in MATLAB	
P4	Write a program for LU Decomposition.	1	Ability to solve simultaneous equations using MATLAB	CO1
P5	Program to implement Gauss-Seidel iteration method.	1	Ability to solve simultaneous equations using MATLAB	CO1
P6	Programming exercise for Newton-Raphson method.	1	Ability to solve polynomials by using MATLAB	CO1
P7	Programming exercise to implement Newton's Forward Interpolation.	1	Ability to interpolate using MATLAB	CO2
P8	Programming exercise to implement Newton's Backward Interpolation.	1	Ability to interpolate using MATLAB	CO2
P9	Programming exercise to implement Newton's divided difference method	1	Ability to interpolate using MATLAB	CO2
P10	Program to implement Lagrange's interpolation.	1	Ability to interpolate using MATLAB	CO2
P11	Program on Trapezoidal's and Simpson's rules	1	Ability to solve definite Integrals by using MATLAB	CO2
P12	Program to implement Euler's modified method	1	Ability to solve ordinary differential equation by using MATLAB	CO3
P13	Program for Runge-Kutta method	1	Ability to solve ordinary differential equation by using MATLAB	CO3
P14	Summary of first set of experiments	1	Practice Lab	
P15	Summary of second set of experiments	1	Practice Lab	

COURSE SCHEDULE: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities)

TABLE 4.2: COURSE BROAD SCHEDULE				
Sl. No.	**ACTIVITY**	**PLANNED STARTING DATE**	**PLANNED CONCLUDING DATE**	**TOTAL NUMBER OF PERIODS**
01	**Over View of the course**	**16/2/23**	**16/2/23**	**1**
02	**Module : 01**	**17/2/23**	**17/3/23**	**5**
03	**Module: 02**	**20/3/23**	**11/4/23**	**3**
04	**Midterm**	**12/4/23**	**15/4/23**	**--**
05	**Module: 02**	**17/4/23**	**28/4/23**	**2**
06	**Assignment**	**2/5/23**	**12/5/23**	**--**
07	**Module:03**	**2/5/23**	**2/6/23**	**5**
08	**End term**	**7/6/23**	**24/6/23**	**--**

DETAILED SCHEDULE OF INSTRUCTION:

SELF LEARNING COMPONENT: Secant method, numerical differentiation, backward differences - Crank-Nicolson method.

MAIN PEDAGOGY: Lecture

TABLE 5.2: DETAILED COURSE SCHEDULE/ LESSON PLAN				
Session no	**TOPIC**	**SUBTOPIC**	**CO Number**	**Reference**
L1	Numerical Methods	Course Overview		
L2	Numerical solution of system of linear equations	Introduction to system of linear equations	**CO1**	**T1(3)**
L3	Numerical solution of system of linear equations	LU decomposition method	**CO1**	**T1(3)**
L4	Numerical solution of system of linear equations	LU decomposition method	**CO1**	**T1(3)**
L5	Numerical solution of system of linear equations	Gauss-Seidel iteration method.	**CO1**	**T1(3)**
L6	Numerical solution of algebraic and transcendental equations	Newton-Raphson method	**CO 1**	**T1(2)**
End of module 1				
L7	Numerical Interpolation	Newton's forward and backward interpolation method	**CO2**	**T1(4)**
L8	Numerical Interpolation	Newton's divided difference method	**CO2**	**T1(4)**
L9	Numerical Interpolation	Lagrange's method	**CO2**	**T1(4)**

L10	Numerical Integration	Trapezoidal rule	**CO2**	**T1(5)**
L11	Numerical Integration	Simpson's one-third rule, Simpson's three-eighth rule.	**CO2**	**T1(5)**
End of module 2				
L12	Numerical solution of ODEs	Modified Euler's method	**CO3**	**T1(5)**
L13	Numerical solution of ODEs	Modified Euler's method	**CO3**	**T1(5)**
L14	Numerical solution of ODEs	4th order Runge-Kutta method	**CO3**	**T1(5)**
L15	Numerical solution of PDEs	Forward differences - Crank-Nicolson method.	**CO3**	**T2(21)**
L16	Numerical solution of PDEs	Central differences - Crank-Nicolson method.	**CO3**	**T2(21)**
End of module 3				

ASSESSMENT SCHEDULE

TABLE 6 ASSESSMENT SCHEDULE							
Sl.no	**Assessment type[Include here assessment method for self-learning component also]**	**Contents**	**Course outcome Number**	**Duration In Hours**	**marks**	**Weightage**	**Venue, DATE &TIME**
1	**Midterm**	**Module 1 and 2**	**CO1, CO2**	**1 hour 30 minutes**	**50**	**25%**	As per the academic calendar
2	**Review of digital / e-resources from presidency university link given in the reference section (mandatory to submit screenshot accessing digital resource. Otherwise it will not be evaluated)- Assignment**	**Module 1, 2 and 3 https://puniversity.knimbus.com**	**CO1, CO2, CO3**	**--**	**10**	**5%**	**--**
3	**Lab**	**All experiments**	**CO1, CO2, CO3**	**--**	**40**	**20%**	**--**
4	**End term**	**Module 1, 2 and 3**	**CO1, CO2, CO3**	**3 hours**	**100**	**50%**	To be announced by COE

EVALUATION FOR DAILY EXPERIMENTS:

Attendance	**Write up**	**Output**	**Viva/Execution**	**Total marks**	**Weightage**
3	**4**	**1**	**2**	**10**	**5%**

COURSE CLEARANCE CRITERIA: As per Academic Regulations of the University

MAKEUP EXAM POLICY: As per Academic Regulations of the University

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: Chamber consultation hour will be announced in class by respective faculty.

SAMPLE THOUGHT PROVOKING QUESTIONS:

TABLE 7: SAMPLE THOUGHT PROVOKING QUESTIONS

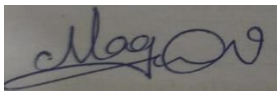
<table>
<tr><th>SL NO</th><th>QUESTION</th><th>MARKS</th><th>COURSE OUTCOME NO.</th><th>BLOOM'S LEVEL</th></tr>
<tr><td>1</td><td>Discuss the values of x_1, x_2 and x_3 for the system of equations by iterative method
$5x_1 - 2x_2 + 3x_3 = -1$, $-3x_1 + 9x_2 + x_3 = 2$ and
$2x_1 - x_2 - 7x_3 = 3$</td><td>10</td><td>CO1</td><td>Comprehension</td></tr>
<tr><td>2</td><td>The population of a city in censes taken once in 10 years is given below. Estimate the population in the year 1955.
<table><tr><td>Year</td><td>1951</td><td>1961</td><td>1971</td><td>1981</td></tr><tr><td>Population in Lakhs</td><td>35</td><td>42</td><td>58</td><td>84</td></tr></table></td><td>10</td><td>CO2</td><td>Comprehension</td></tr>
<tr><td>3</td><td>Discuss the values of the integral $\int_0^1 \frac{x^2}{1+x^3}\, dx$ using appropriate method of numerical integration</td><td>10</td><td>CO3</td><td>Comprehension</td></tr>
</table>

Sample Thought Provoking Questions to be asked to Assess the Students' Preparedness to carry out the Task [For Laboratory Component]:

Sl No.	Question	Task No.	Course Outcome No.
1	Using MATLAB, print the solution of the equation $f(x) = x^3+2x^2+x-1$ using appropriate numerical method.	2	CO1
2	Using MATLAB, print the solution of an ordinary differential equation $dy/dx = x^2 + y^2$, $y(1) = 1.2$. and find $y(1.05)$ using appropriate numerical method.	4	CO3

TARGET SET FOR COURSE OUTCOME ATTAINMENT:

TABLE 8: TARGET SET FOR ATTAINMENT OF EACH CO and ATTAINMENT ANALYSIS AFTER RESULTS						
Sl.no	**C.O. No.**	**Course Outcomes**	**Threshold Set for the CO**	**Target set for attainment in percentage**	Actual C.O. Attainment In Percentage *	Remarks on attainment &Measures to enhance the attainment *
01	CO1	Solve algebraic and transcendental equations numerically.	55%	60%		
02	CO2	Use numerical techniques to differentiate and integrate functions.	55%	65%		
03	CO3	Apply numerical methods to solve ordinary differential equations.	50%	60%		



Signature of the course Instructor In-Charge (s)

APPROVAL:

This course has been duly verified Approved by the D.A.C.

Signature of the Chairperson D.A.C.

BLOOM'S TAXONOMY SAMPLE VERBS

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

TABLE 9: REFERENCE SAMPLES OF BLOOMS TAXONOMY VERBS		
Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize, employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	applying knowledge to actual situations
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria