20PEB221					Numerical Methods					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	1	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop skills of the students to solve ordinary and partial differential equations numerically, numerical integrals, algebraic and transcendental equations.
- To understand the fundamental of interpolation techniques and its applications in petroleum engineering.
- To understand the numerical techniques to solve partial and ordinary differential equations and its applications in petroleum science and technology
- To understand basic concepts of curve fitting and regression analysis and its roles in the petroleum technology such as prediction of petrophysical parameters, establishment of various relationship among the geophysical parameters etc.
- To create the understanding of basic concepts of finite elements methods and it's applications in petroleum science and engineering.

UNIT 1 ROOT FINDING **10 Hrs**

Introduction, Descarte's Sign rule, Bisection Method, Method of false position, Secant method, Iteration method, Extended method of iteration, Newton-Raphson method, It's applications, Solution of nonlinear simultaneous equations, Newton-Raphson method for multiple roots, Horner's method, Lin-Bairstow's method or Method for Complex Root, Graeffe's root squaring method, Comparison of various

UNIT 2 FINITE DIFFERENCES AND INTERPOLATION **11HRS**

Finite Differences: Introduction, Finite differences, Operators: Forward Difference, Backward Difference, Central Difference, Shift Operator, Averaging Operator. Relation between operators, Factorial Notation, Synthetic Division, and Missing term Technique.

Interpolation: Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Gauss's Forward and Backward Interpolation Formula, Stirling'sCentral Difference Formula, Lagrange's Interpolation Formula for unevenly spaced Formula, Inverse Interpolation, Divided Differences, Properties of Divided Differences, Newton's Divided Difference Formula, Relation between Divided Differences and Ordinary Differences.

UNIT 3 NUMERICAL DIFFERENTIATION & INTEGRATION ODE, PDE, SIMULENEOUS EQUATIONS **12 HRS.**

Numerical Differentiation: Introduction, Formulae for Derivatives.

Numerical Integration: Introduction, Newton-Cotes's Quadrature Formula, Trapezoidal rule, Simpson'sone-third rule, Simpson's Three-Eighth rule, Weddle's rule, Romberg's method, Double Integration.

Solution of Simultaneous Algebraic Equations: Direct methods, Iterative methods: Gauss-Jacobi's method, Gauss-Seidal method, Relaxation method.

Numerical Solution of Ordinary Differential Equation: Taylor's method, Euler's method, Runge – Kuttamethod, Modified Euler's method, Predictor Corrector method: Adam's method& Milne's method.

Numerical Solution of Partial Differential Equation: Difference Quotients, Graphical representation, Classification of PDE's of 2nd order, Elliptic equations, Solutions of Laplace equation by Liebmann's iteration method, Poisson's equation, Parabolic equation(One dimension heat equation), Bender-Schmidt method Crank- Nicholson method.

UNIT 4 FEM **07 HRS.**

Introduction to Finite Elements Methods: Introduction to Finite Element Methods, Functionals, Base Functions. Methods of Approximation: The Rayleigh-Ritz Method, The Galerkin Method. The FEM for one dimensional Problems and applications to two dimensional problems.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Apply the numerical methods to solve ODE and PDE in reservoir simulation and modelling, fluid flow through porous media and in various applications in petroleum science and technology.

CO2 Construct relationships among various petrophysical parameters, geological parameters, geophysical parameters etc with the help of curve fitting and regression analysis.

CO3 - Understand the applications of partial differential equation in the field of petroleum science and technology such as fluid flow through porous media, seismic wave propagation through the interior of Earth, reservoir simulation and modelling etc.

CO4 - Solve the real life applications of finite elements method in the field of petroleum science

TEXT/REFERENCE BOOKS

1. Numerical Methods in Engineering and Science with Programs in C & C++ by B.S. Grewal, Khanna Publisher.
2. Introductory Methods for Numerical Analysis by S.S. Sastry, Fourth edition, Prentice Hall of India.
3. Numerical Methods for Scientific and Engineering Computation by M.K. Jain, S.R.K. Iyenger and R.K. Jain, 5th edition, New Age International .
4. An introduction to Finite Element Method By J N Reddy, Mc Graw Hill.
5. Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyenger, 3rd edition, Narosa .
6. Numerical Methods for Engineers by S C Chapra , Raymond P. Canale, Tata McGraw Hill Pub. Co. Ltd.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A : 4 questions of 6 marks each 24 Marks (40 min)

Part B: 4 questions of 10 marks each 40 Marks (80 min)

Part C: 3 questions of 12 marks each 36 Marks (60 min