B.A./B.Sc. III (SEMESTER-VI) PAPER-I METRIC SPACES & COMPLEX ANALYSIS

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030601T	Course Title: METRIC SPACES & COMPLEX ANALYSIS	

Course outcomes:

CO1: The course is aimed at exposing the students to foundations of analysis which will be useful in understanding various physical phenomena and gives the student the foundation in mathematics.

CO2: After completion of this course the student will have rigorous and deeper understanding of fundamental concepts in Mathematics. This will be helpful to the student in understanding pure mathematics and in research.

CO3: Students will be able to know the concepts of metric space, basic concepts and developments of complex analysis which will prepare the students to take up further applications in the relevant fields.

Credits: 4	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Part- A
Metric Spaces

Unit	Topics	No. of Lectures
I	**Basic Concepts-** Metric spaces**:** Definition and examples, Diameters in Metric space, Bounded and Unbounded Metric space.	8
II	**Topology of Metric Spaces** Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set. Subspaces, Dense set.	8
III	**Completeness in Metric Spaces** Sequences and sub sequences in metric spaces, Convergent Sequences in metric spaces, Cluster point of a sequence, Cauchy sequences in a Metric space, Definition of Complete Metric space and examples and cantor's intersection theorem	7
IV	**Continuity & Uniform Continuity in Metric Spaces** Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity of composite functions, Homomorphism, Characterization of Homomorphism	7

Part- B
Complex Analysis

Unit	Topics	No. of Lectures
V	Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae.	8
VI	Analytic Functions Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples, Harmonic function Method of constructing a regular function (Milne-Thomson's method).	8
VII	Conformal mapping, necessary and sufficient condition, Inverse point, Bilinear transformation, critical point, cross ratio, fixed point.	7
VIII	Exponential function, Logarithmic function, Branches and derivatives of logarithms, Trigonometric function, Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.	7

Suggested Readings (Part-A Metric Space):

1. M K Singal and A R Singal , **Topics in Analysis II** 2017
2. Shirali, Satish & Vasudeva, H. L., **Metric Spaces**, Springer, First Indian Print. 2009
3. Kumaresan, S., **Topology of Metric Spaces** Narosa Publishing House, 2014
4. Simmons, G. F. **Introduction to Topology and Modern Analysis,** Tata McGraw Hill. 2004
5. Suggested digital platform: NPTEL/SWAYAM/MOOCS.

Suggested Readings (Part-B Complex Analysis):

1. Shanti Narain , Function of Complex Variable, S Chand, 2005
2. S Ponnusamy, **Functions of Complex Analysis**, Narosa, 2005
3. Brown & Churchill, **Complex variable and applications,** 2013
4. Suggested digital platform: NPTEL/SWAYAM/MOOCS

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), B.Sc.(C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation**	5
4	**Assignment**	5

Course prerequisites: To study this course, a student must have Diploma in Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-II Numerical Analysis & Operation Research

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030602T	Course Title: Numerical Analysis & Operations Research	

Course outcomes:

CO1: The aim of this course is to teach the student the application of various numerical technique for variety of problems occurring in daily life. At the end of the course the student will be able to understand the basic concept of Numerical Analysis and to solve algebraic and differential equation.

CO2: The main outcome will be that students will be able to handle problems and finding approximated solution. Later he can opt for advance course in Numerical Analysis in higher Mathematics.

CO3: The student will be able to solve various problems based on convex sets and linear programming. After successful completion of this paper will enable the students to apply the basic concepts of transportation problems and its related problems to apply in further concepts and application of operations research.

Credits: 4	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

PART-A
Numerical Analysis

Unit	Topics	No. of Lectures
I	**Errors in Computation-** Floating point representation of numbers, Significant Digits, Rounding and chopping, Absolute and relative errors, computation of errors using differentials, Truncation error. Solution of non-linear equations: bisection, Secant, Regular Falsi, Newton Raphson's method.	8
II	**Interpolation-**Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula.	8
III	**Numerical differentiation** -Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Numerical Integration: Trapezoidal, Weddle, Simpsons Newton Cotes Formulas, Gaussian Quadrature Formulas.	7
IV	**System of Linear equations**: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods).	7

PART-B
Operations Research

Unit	Topics	No. of Lectures
V	Operations research and its scope, Linear programming problems, statement and formation of general linear programming problems, graphical method, slack and surplus variables, standard and matrix forms of linear programming problem, basic feasible solution.	8
VI	Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method Big-M method and their comparison.	8
VII	Resolution of degeneracy, duality in linear programming problems, primal dual relationships, revised simplex method.	7
VIII	Transportation problems, assignment problems.	7

Suggested Readings (Part-A Numerical Analysis):

1. MK. Jain, S.R.K. Iyengar & R.K. Jain, **Numerical Methods for Engineering and scientific computation,** New Age Publishers, 2009
2. S. S. Sastry, **Introductory methods of Numerical Analysis, PHI, 2012**
3. Suggested digital platform: NPTEL/SWAYAM/MOOCs

Suggested Readings (Part-B Operations Research):

1. Taha, Hamdy H, **Operations Research- An Introduction**, Pearson Education. 2017
2. Hillier Frederick S and Lieberman Gerald J., **Introduction to Operations Research**, McGraw Hill Publication. 2012
3. Winston Wayne L., **Operations Research: Applications and Algorithms**, Cengage Learning, 4th Edition., 2004
4. Hira D.S. and Gupta Prem Kumar, **Problems in Operations Research**: Principles and Solutions, S Chand & Co Ltd., 1995
5. Suggested digital platform: NPTEL/SWAYAM/MOOCs.

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics (UG/PG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics

Suggested equivalent online courses:

Further Suggestions:

B.A./B.Sc. III (SEMESTER-VI) PAPER-III Practical

Programme: Degree Class: B.A./B.Sc.	Year: Third	Semester: Sixth
Subject: Mathematics		
Course Code: B030603P	Course Title: Practical	

Course outcomes:
The main objective of the course is to equip the student to solve the transcendental and algebraic equations, system of linear equations, ordinary differential equations, Interpolation, Numerical Integration, Method of finding Eigenvalue by Power method (up to 4×4), Fitting a Polynomial Function (up to third degree).

Credits: 2	Core Compulsory / Elective
Max. Marks: 25+75	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-4

Unit	Topics	No. of Lectures
	Practical / Lab work to be performed in Computer Lab. List of the practical to be done using computer algebra software (CAS), for example R/Python/Mathematica/MATLAB/Maple/ Maxima/Scilab etc. 1. Solution of transcendental and algebraic equations by i. Bisection method ii. Newton Raphson method (Simple root, multiple roots, complex roots). iii. Secant method iv. Regula Falsi method. 2. Solution of system of linear equations i. LU decomposition method ii. Gaussian elimination method iii. Gauss-Jacobi method iv. Gauss-Seidel method 3. Interpolation i. Lagrange Interpolation ii. Newton's forward, backward and divided difference interpolations 4. Numerical Integration i. Trapezoidal Rule ii. Simpson's one third rule iii. Weddle's Rule iv. Gauss Quadrature 5. Method of finding Eigenvalue by Power method (up to 4×4) i. Runge Kutta method (order 4) ii. The method of successive approximations (Picard)	

Suggested Readings:

This course can be opted as an elective by the students of following subjects: Engg. and Tech. (UG), Economics (UG/PG), B.Sc. (C.S.)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	Class Tests	10
2	Online Quizzes/ Objective Tests	5
3	Presentation	5
4	Assignment	5

Course prerequisites: To study this course, a student must have Certificate Course in Applied Mathematics

Suggested equivalent online courses:

Further Suggestions: