Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil Mahavidyalaya, Pandharpur

(Autonomous)

Third Year Syllabus under Autonomy

NAAC Reaccredited 'A^{+}' grade, CGPA: 3.51

Granted under FIST-DST and the Best College

Affiliated

To

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Program: B.Sc. III

Subject: Mathematics

Semester: V and VI

Pattern: Choice Based Credit System (CBCS)

Revised Structure of

Syllabus to be implemented from June, 2021 onwards

Rayat Shikshan Sanstha's
Karmaveer Bhaurao Patil Mahavidyalaya, Pandharpur
(AUTONOMOUS)

Revised Structure of Syllabus

for B.Sc. Part - III Mathematics
Choice Based Credit System (CBCS) Syllabus
June, 2021

Structure of the Course:

1. B.Sc. course in Faculty of "Science & Technology" has total of **six** (6) semesters for **three** (3) years.
2. B.Sc.-III comprises of total **two** (2) semesters. Each semester will have **Four** (4) theory papers of 80 marks each for semester end examination (SEE) and 20 marks for Continuous Cumulative Evaluation (CCE) which includes one of the evaluation methods such as group discussion, seminar, unit test, social responsibility activity etc. in each semester.
3. There is a **Skill Enhancement Course** for Semester –VI.
4. At the end of academic year i.e., semester VI the practical examination will be conducted (Annual). The weightage of practical is of 320 marks for annual practical examination and 80 marks for continuous cumulative evaluation.
5. Title, distribution of marks for each paper is as follows:

Semester	Paper No & Paper Code No.	Title of Paper	Hrs./week		Examination Marks			Total Credit
			L	P	Semester End Examination (SEE)	Continuous Cumulative Evaluation (CCE)	Total	
	Core Courses (Compulsory Papers)							
V	Ability Enhancement Course (AECC) Paper II Part A	English (Business English)	4	--	40	10	50	2.0
	Paper-IX: KBP-S-MAT-3509	Algebra II	4	--	80	20	100	4.0
	Paper-X: KBP-S-MAT -3510	Complex Analysis	4	--	80	20	100	4.0
	Paper-XI: KBP-S-MAT -3511	Integral Calculus	4	--	80	20	100	4.0
	DSE: Discipline Specific Elective Paper (Any One)							
	Paper-XII: DSE-1A KBP-S-MAT -3512	Partial Differential Equations	4	--	80	20	100	4.0
	Paper-XII: DSE-2A KBP-S-MAT -3512	Operation Research	4	--	80	20	100	4.0
	Total (Theory)		**20**	--	**360**	**90**	**450**	**18**

	Core Courses (Compulsory Papers)							
VI	Ability Enhancement Course (AECC) Paper II Part B	English (Business English)	4	--	40	10	50	2.0
	Paper-XIII: KBP-S-MAT -3613	Metric Space	4	--	80	20	100	4.0
	Paper-XIV: KBP-S-MAT-3614	Numerical Analysis	4	--	80	20	100	4.0
	Paper-XV: KBP-S- MAT -3615	Graph Theory	4	--	80	20	100	4.0
	DSE: Discipline Specific Elective Paper (Any One)							
	Paper-XVI: DSE-1B KBP-S- MAT-3616	Integral Transform	4	--	80	20	100	4.0
	Paper-XVI: DSE-2B KBP-S- MAT-3616	Programming in C	4	--	80	20	100	4.0
	SEC: Skill Enhancement Course							
	Paper Code: KBP-S- MAT -36-SC	Add-On-SEC Quantitative Aptitude	2	2	80	20	100	4.0
	Total (Theory)		**22**	**2**	**440**	**110**	**550**	**22**

Annual Practical	**P-3 (Annually)**	**Practical (I)**	--	5	80	20	100	4.0
		Practical (II)	--	5	80	20	100	4.0
		Practical (III)	--	5	80	20	100	4.0
		Practical (IV)	--	5	80	20	100	4.0
	Total (Practicals)			**20**	**320**	**80**	**400**	**16**
	Grant Total		**42**	**22**	**1120**	**280**	**1400**	**56**

- **Semester Examination**
  - All Theory Papers of Science Faculty: Each Paper of 80 Marks of Semester End Examination (SEE) + 20 Marks of Continuous Cumulative Evaluation (CCE)
  - Compulsory English Paper is of 40 Marks of Semester End Examination (SEE) + 10 Marks of Continuous Cumulative Evaluation (CCE).
- **Practical Examination will be held at the end of the year-400 marks**
  - **Practical**: 320 Marks of Annual Practical Examination + 80 Marks Continuous Cumulative Evaluation (CCE)
  - **Duration of Examination –** Two days, 6 hrs. per day
- **Continuous Cumulative Evaluation (CCE):**
  - Each theory paper of Mathematics will have 20 marks for continuous cumulative evaluation (CCE) in each semester.
  - Compulsory English Paper will have 10 Marks of Continuous Cumulative Evaluation (CCE) in each semester.
  - Practical paper will have 80 marks for continuous cumulative evaluation (CCE).
- **There will be separate passing criterion for SEE and CCE**
- **Student shall complete Skill Enhancement Course in semester- VI.**
- **Medium of Instruction:** English
- **Scheme of Practical Examination for B. Sc. Part – III**

1. Practical examination will be conducted annually.
2. Practical examination will be conducted for Two days per batch.
3. The examination will be conducted in two sessions per day and each session will be of three hours duration.
4. Every candidate should present Seminar-Report, Tour-Report & Journal.
5. Every candidate should present Scientific Project.
6. Study tour anywhere in India is compulsory.
7. **At least eighty percent (80%) practical** should be completed by the student.

Class	Semester	Marks-Theory	Credits-Theory	Marks-Practical	Credits-Practical	Total Credits
B.Sc.-III	V	450	18	--	--	18
	VI	550	20	400	18	38
Total		1000	38	400	18	56

B.Sc. Programme:

Total Marks : Theory + Practical's = 1000 +400 = 1400

Credits : Theory + Practical's = 38 + 18= 56

Numbers of Papers: Theory: Ability Enhancement Course (AECC) : 02

Theory: Discipline Specific Elective Paper (DSE) : 02

Theory: DSC : 06

Skill Enhancement Course : 01

Total: Theory Papers : 11

Practical Papers : 05

B.Sc.-III (MATHEMATICS)

CBCS pattern Syllabus w.e.f. June – 2021

Structure of the Revised Course: -

SEMESTER – V

(I) Theory Papers: -

Paper	Title of the Paper	Marks
IX	Algebra – II	80+ 20 = 100
X	Complex Analysis	80+ 20 = 100
XI	Integral Calculus	80+ 20 = 100
XII	Partial Differential Equations (Elective - A)	80+ 20 = 100
	Operation Research (Elective - B)	80+ 20 = 100

SEMESTER – VI

(II) Theory Papers: -

Paper	Title of the Paper	Marks
XIII	Metric Spaces	80+ 20 = 100
XIV	Numerical Analysis	80+ 20 = 100
XV	Graph Theory	80+ 20 = 100
XVI	Integral Transform (Elective - A)	80+ 20 = 100
	Programming in C (Elective - B)	80+ 20 = 100

Equivalent Subject for Old Syllabus

Sem-V

Sr. No.	Name of the Old Paper	Name of the New Paper
1	Paper-IX: Algebra – II	Paper-IX: Algebra - II
2	Paper-X: Complex Analysis	Paper-X: Complex Analysis
3	Paper-XI: Integral Calculus	Paper-XI: Integral Calculus
4	Paper-XII: Partial Differential Equations (Elective - A)	Paper-XII: Partial Differential Equations (Elective - A)
	Paper-XII: Mathematical Analysis (Elective - B)	Paper-XII: Operation Research (Elective - B)

Sem-VI

Sr. No.	Name of the Old Paper	Name of the New Paper
1	Paper-XIII: Metric Spaces	Paper-XIII: Metric Spaces
2	Paper-XIV: Numerical Analysis	Paper-XIV: Numerical Analysis
3	Paper-XV: Programming in C	Paper-XV: Graph Theory
4	Paper-XVI: Integral Transform (Elective - A)	Paper-XVI: Integral Transform (Elective - A)
	Paper-XVI: Graph Theory and Combinatory (Elective - B)	Paper-XVI: Programming in C (Elective - B)

Numerical Technique Laboratory (NTL)

NTL No.	Topic	Marks
NTL-III (A)	S-I: Algebra-II [6] S-II: Metric Space [6] +Seminar	80+ 20 = 100
NTL-III (B)	S-I: Complex Analysis [6] S-II: Numerical Analysis [6] + project	80+ 20 = 100
NTL-III (C)	S-I: Integral Calculus [6] S-II: Graph Theory [6] +Study Tour/Book review	80+ 20 = 100
NTL-III (D)	S- I: Partial Differential Equation [6] OR S-I: Mathematical Analysis [6]	80+ 20 = 100
	S- II: Integral Transform [6] OR S-II: Programming in C [6] + Viva Voce	80+ 20 = 100

Note: Number inside the bracket [ ] indicates the number of assignments.

In Numerical Technique Laboratory: NTL - III (A) - III (D) [Project / Seminar / Study Tour/ Viva-Voce / Book Review]

Project: Biography of One Mathematician or One Mathematics Topic (which is not included in the syllabus up to B.Sc.-III Mathematics) about five Pages. **10 Marks**

Seminar: Any topic in mathematics. **10 Marks**

Book Reviews: Mathematics Book other than text book **10 Marks**

Study Tour: Visit to any Industry / Research Institution / Educational Institution. **10 Marks**

Viva Voce: Viva voce on Project, Seminar, Book review and Study Tour. **10 Marks**

(Free internet should be availed for collection of Material for Project, Seminar.)

Distribution of each Theory paper (Marks 100)

Semester End Examination (SEE):	**80 Marks**
Continuous Cumulative Evaluation (CCE):	**20 Marks**

Scheme of Continuous Cumulative Evaluation.

1. Unit Test:	**10 Marks**
2. Home Assignment:	**10 Marks**

Distribution of Practical Examination Marks (100):

Practical examination will be at the end of sixth semester. The candidate has to perform eight practicals', one from each group.'

A. Semester End Examination (SEE) for Practical: (80) Marks:

a) Problems from NTL (A) 80: [S – I: 30 M + S – II: 30 M + Seminar: 10 M + J: 10 M]

b) Problems from NTL (B) 80: [S – I: 30 M + S – II: 30 M + Project: 10 M + J: 10 M]

c) Problems from NTL (C) 80: [S – I: 30 M + S – II: 30 M +Study tour/Book preview: 10 M + J: 10 M]

d) Problems from NTL (D) 80: [S – I: 30 M + S – II: 30 M + Viva voce: 10 M + J: 10 M]

B. Continuous Cumulative Evaluation for Practical: (20 marks)

Scheme of Marking: 10 Marks: Internal Test on each NTL

10 Marks: Home assignment/oral/Seminars/Conference /Industrial Visit/Group Discussion/Viva, etc. on each NTL

Instructions:

1. Each Theory Paper is allotted 60 periods per semester.
2. All **Numerical Technique Laboratories (NTL)** (similar to Practical) will be conducted in the batch as a whole Class.
3. Total evaluation of B.Sc. III (1500 Marks.)

[Theory papers (1100 Marks)

+

[Practical NT L-III (A) to III (D) (400 Marks)

4. The annual **Numerical Technique Laboratory (NTL - III (A) to III (D)]** will carry **100** Marks each.
5. Department of Mathematics should provide FIVE computers per batch of TEN Students

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Nature of paper of Numerical Technique Laboratory

(For NLT - III (A) to NLT - III (D))

I) Attempt THREE out of SIX (each of 10 marks)	**- 30 Marks**
OR Attempt SIX out of EIGHT (each of 05 marks)	
II) Attempt THREE out of SIX (each of 10 marks)	**- 30 Marks**
OR Attempt SIX out of EIGHT (each of 05 Marks)	
III) Seminar/Project/Study Tour/Viva-voce/Book Review	**- 10 Marks**
IV) Journal	**- 10 Marks**
	Total- 80 Marks

SEMESTER: V

Paper IX: KBP-S-MAT-3509: Algebra II
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Student should

1. analysis vectors in $R\hat{}n$ geometrically and algebraically.
2. recognize the concepts of the terms span, linear independence, basis, and dimension and apply these concepts to various vector spaces and subspaces.
3. use matrix algebra and the related matrices to linear transformations.
4. to understand the concepts of Rings and their types.
5. to understand the Inner products Space and Norms.

Unit - 1: Introduction to Rings. **(15)**

Definitions and examples, Integral domains, Subrings, Fields, Isomorphism, Characteristic of rings

Unit - 2: Quotient Rings. **(10)**

Homomorphism of rings, Ideals, Quotient rings

Unit - 3: Vector Spaces **(10)**

Vector spaces, Subspaces, Linear combination and system of linear equation, Linear dependence and independence, Basis and Dimensions.

Unit - 4: Linear transformation and matrices **(15)**

Linear transformation, null spaces and range, Matrix representation of linear transformation, composition of linear transformation and matrix multiplication, Inevitability and isomorphism of linear transformation.

Unit - 5: Inner product space **(10)**

Inner products and Norms.

Learning Outcomes:

After completion, Students are able to:

1. identify and construct linear transformations of a matrix.
2. solve linear systems represented as linear transforms.
3. express linear transforms in other forms, such as matrix equations, and vector equations.
4. identify and construct Homomorphism of rings and ideals.
5. characterize linear transformations as onto, one-to-one.

Recommended books (Scope of Syllabus):

Modern Algebra-An Introduction, by John R. Durbin, John Wiley & Sons, Inc. Fifth Edition.

Unit - 1: Chapter - VI: Art. 24, 25, 26, 27

Unit - 2: Chapter - IX: Art. 38, 39

Linear Algebra Fourth Edition by Stephen H. Friedberg, Arnold J. Insel Lawrence E. Spence Prentice Hall of India New Delhi (EEE)

Unit 3: Chapter - I (Vector Spaces): Art. 1.2 to 1.6

Unit 4: Chapter-II (Linear transformation and matrices): Art.2.1 to 2.4

Unit 5: Chapter - VI (Inner product space) Art. 6.1

Reference Books:

1. A First Course in Abstract Algebra by J. B. Fraleigh, Pearson Education 7th edition.
2. University Algebra by N.S. Gopalakrishnan
3. Fundamental of Abstract Algebra by D.S. Malik & N. Mordeson & M.K. Sen, Mc. Graw Hill International Edition.
4. Liner Algebra by Vivek Sahai & Vikas Bist, Narosa Publishing House.
5. Topics in algebra by John Wiley & Sons and by I.N. Herstein
6. Abstract algebra by K.S. Bhambri and Khanna Vijay

Paper X: KBP-S-MAT-3510: Complex Analysis
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Student should

1. understand and learn to use Argument Principle
2. to understand the principle of Analytic continuation and the concerned results.
3. to study the functions with positive real part.
4. to understand the Harmonic functions on a disc and concerned result.
5. to understand the range of analytic functions and concerned result.

Unit - 1. Analytic Functions **(15)**

Complex Differentiation, Limits and Continuity, Differentiability, Necessary and sufficient condition of analytic function, Method of constructing a regular function and analytic function, Simple method of constructing analytic function, Polar from of Cauchy-Riemann Equations.

Unit - 2: Complex Integration **(25)**

Introduction, Some basic definitions, Complex integral, Reduction of complex integrals to real integrals, Some properties of complex Integrals, An estimation of a complex integral, Line integrals as functions of arcs, Cauchy's Fundamental Theorem (Theorem-I), Cauchy Goursat Theorem [Statement Only], Cauchy's Integral formula [Statement only], its consequences and examples, Derivative and higher order derivatives of an analytic function [Statement(s) only] and examples, Expansions of Analytic functions as power series (Taylor's Maclaurin's and Laurent's Series [Statement only]) and its examples, The zeros of an analytic function, Different Types of Singularities, Some Theorems on Poles and other Singularities (Theorem-I to IV only) and its examples, The point at infinity

Unit - 3: Calculus of Residues **(20)**

Residue at simple pole, Residue at a Pole of order greater than unity, Residue at infinity, Cauchy's Residue Theorem, Evaluation of Definite integrals, Integration around the unit Circle. Evaluation of $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$.

Learning Outcomes:

After completion, Students are able to:

1. calculate the Analytic functions.
2. express the residue theorem.
3. classify Singularities.
4. calculate complex integrals using Residue theorem.
5. calculate Real integrals using Residue theorem.

Recommended Book (Scope of Syllabus):

1. **Functions of Complex Variable** by J.N. Sharma Revised by Dr. Shanti Swarup, (38 Edition) Krishna Prakashan Media Ltd., Meerut.

   Chapter - 2 (Analytic Functions): Art. 1 to 7
   Chapter - 6 (Complex Integration): Art. 1 to 8, 9 (Statement only), 19 (Theorem-1, Theorem- II (Statements only),20, 21, 22 [Theorems I to IV only], 23. 24.
   Chapter- 7 (Calculus of Residues): Art. 1 to 6.

Reference Books: -

1. Graduate texts in mathematics functions of one complex variable – J. B. Conway.
2. Theory of functions of a complex variable- Shanti Narayan, P. K. Mittal, Chand Publication.
3. A function of complex variable by A. R. Vasishta.
4. Complex variables and applications by J. W. Brown, J. R. Churchill.

Paper XI: KBP-S-MAT-3511: Integral Calculus
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Student should

1. calculate an improper integral where at least one of the bounds is not a real number.
2. calculate an improper integral where the integrand is discontinuous at one or more points in the interval of integration.
3. evaluate definite and indefinite integrals using techniques including change of variables.
4. apply double integration techniques in evaluating volume of solid.

Unit - 1. Improper Integrals **(25)**

Convergence of Improper integrals of the first kind, Test of convergence of a (Positive integrands), Necessary and sufficient condition for the convergence of improper integrals, Comparison of two integrals, Practical comparison test, Useful comparison integrals, Two useful tests, f(x) not necessarily positive general test for convergence, Absolute and conditionally convergence, Convergence of improper integrals of the second kind, Convergence at infinity (Integrand being positive), Comparison of two integrals, useful comparison integrals, General test (for convergence at infinity and f(x) may be positive or negative), Cauchy's test for convergence, Absolute and conditionally convergence of improper integrals of second kind, Test for the absolute convergence of the integral of product, Abel's test, Dirichlet's test.

Unit - 2: Beta and Gamma function: **(20)**

Definition, Properties, Transformations of Gamma function and Beta function, Relation between Beta and Gamma functions, Some important deductions, Duplication formula.

Unit - 3: Multiple integrals: **(15)**

Double Integrals, Cartesian and polar, Applications of Double Integration (Area of regions and Volume of a Solid only), Change of order of integration, Change of Variables.

Learning Outcomes:

After completion, Students are able to:

1. express the area as a limit of an infinite sum
2. compute indefinite and definite integral using by the method of substitution.
3. evaluate improper integrals.
4. use integration to calculate areas of regions in a plane, volumes of solids.
5. compute indefinite and definite integrals using by techniques of integration.

Recommended Book:

Integral Calculus by Shanti Narayan and P.K. Mittal S. Chand publication Revised Edition - 2005.
Unit 1: Article 16.1 to 16.18
Unit 2: Article 7.1, 7.2, 7.3, 7.4, 7.5
Unit 3: Article 12.1, 12.2, 12.3, 12.4, 12.5

Reference books: -

1. N. Pisknov, Differential and Integral Calculus, Peace Publishers, Moscow
2. P.N. Wartikar and J.N. Wartikar, A Text Book of Applied Mathematics, Vol. I, Poona Vidyarthi Griha Prakashan, Poona 30.
3. Tom M. Apostol, Calculus Vol I and II, Wiley Publication.
4. Mathematical Analysis by S.C. Malik and Savita Arora.

Paper XII: KBP-S-MAT-3512: Partial Differential Equations (Elective-A)
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Student should

1. able to form, solve, and apply homogeneous partial differential equations of order one to solve physical problems
2. learn to form, solve first order non-homogeneous partial differential equations and methods of finding solutions of these partial differential equations.
3. solve first order partial differential equation by Charpit's Method
4. learn to solve Linear partial differential equation with constant Coefficient

Unit - 1: Linear Partial differential equation of order one **(20)**

Formation of partial differential equation by eliminating arbitrary constants, Formation of partial differential equation by eliminating arbitrary functions. Types of integrals of partial differential equation, Lagrange's Method of solving linear partial differential equation of order one namely $Pp + Qq = R$ (Working rule for solving $Pp+Qq = R$ by Lagrange's Method), Integral surface passing through a given curve.

Unit- 2: Non-Linear partial differential equation of order one **(20)**

Solution of first order partial differential equation by Charpit's Method, Special methods of solution applicable to certain standard form I, II, III, IV.

Unit-3: Linear partial differential equation with constant Coefficient **(20)**

Homogeneous and non – Homogeneous linear partial differential equation with constant coefficients, working rule for finding complementary function (C.F.), method of finding particular integral (P.I.), Short method when $f(x, y)$ is $f(ax + by)$ and $x^m y^n$.

Learning Outcomes:

After completion, Students are able to:

1. solve differential equations using appropriate methods.
2. develop a logical understanding of the subject.
3. explain the concept of a partial differential equation and classify partial differential equations with respect to their order and linearity.
4. find solutions to higher-order linear partial differential equations.
5. solve linear partial differential equations of both first and second.

Recommended Book (Scope of syllabus):

Ordinary and partial differential equation by M.D. Raisinghania, S. Chand Co. [PART - III]

Unit - 1: Chapter -1: 1.1, 1.2, 1.2a, 1.2b, 1.3, 1.4, 1.5, 1.5a, 1.5b, 1.5c,1.5d, 1.6

Unit - 2: Chapter -2: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10

Unit - 3: Chapter - 3: 3.1, 3.2, 3.3, 3.4, 3.4A, 3.4B3.5, 3.6, 3.6A, 3.6B, 3.7, 3.8, 3.9, 3.10

Reference Books:

1) Elements of partial differential equations by IAN Sneddon (International students edition by MC Graw Hill Book)
2) Differential equations Sharma & Gupta (Krishna Prakashan Media (P) Ltd. Meerut)
3) Introduction to Partial differential equations – K. Sankara Rao, PHI Publication
4) Partial Differential Equations by J. M. Kar

Paper XII: KBP-S-MAT-3512: Operations Research (Elective-B)
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Students should

i) understand mathematical models used in operation research
ii) apply these techniques constructively to make effective business decisions.
iii) develops the ideas underlying the Simplex method for Linear programming problem, as an important branch of operations research.
iv) learn Linear programming problems with applications to Transportation and Assignment problem. Such problems arise in manufacturing resource planning and financial sectors.

Unit 1. Modelling with Linear Programming **(15)**

Two variable Linear Programming Model, Solution of Linear Programming Model by Graphical Method, Applications of Linear Programming in Production Planning and Inventory Control (Single Period Production Model, Multiple Period Production Inventory Model, Multiple period Production Smoothing Model, Manpower Planning, Urban Development Planning.

Unit 2. The Simplex Method and Duality **(20)**

Linear Programming Model in equation form, Transition from graphical to algebraic solutions, The Simplex Method, Iterative nature of simplex method, Artificial starting solution, M-Method, Two Phase method, Special cases in Simplex Method such as degeneracy, alternative optima, unbounded solution, infeasible Solution, Definition of the dual problem, Primal dual relationship, Optimal Dual Solution. Additional Simplex Algorithms (Dual Simplex Algorithm, Generalised Simplex Algorithm)

Unit 3. Transportation and Assignment Model **(15)**

Definition of the Transportation model, The Transportation Algorithm, Determination of starting solution (Northwest-corner method, least cost method, Vogel Approximation Method (VAM)), Iterative Computations of the Transportation Algorithm, The Assignment Model, The Hungarian method, Simplex explanation of the Hungarian method.

Unit 4. Games Theory **(10)**

Introduction, Some basic definitions as Saddle point, Payoff matrix, strategy, Optimal Solution of Two-person Zero Sum Game, Solution of Mixed strategy Games (Graphical Solution of games, Linear programming solution of games)

Learning Outcomes:

After completion, students are able to

i) analyse and solve linear programming models of real-life situations.
ii) find graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points.
iii) develop theory of the simplex method.
iv) find the relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

Recommended Book (Scope of Syllabus):

1.Hamdy A. Taha, Operation Research (9th Edition), Pearson Education Inc.
Unit 1: Chapter-2: Art. 1, 2, 4.2, 4.3, 4.4.
Unit 2: Chapter-3: Art. 1, 2, 3 (3.1), 4 (4.1, 4.2), 5 (5.1, 5.2, 5.3, 5.4), Chapter-4: Art. 1, 2, 4 (4.1, 4.2)
Unit 3: Chapter -5: Art. 1, 3 (3.1, 3.2), 4 (4.1, 4.2)
Unit 4: Chapter-13: Art. 4 (4.1, 4.2)

Reference Books:

1. Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operation Research (Eighth Edition) Tata McGraw Hill.
2. J K Sharma, Operations Research (Theory and Applications, second edition, 2006), Macmillan India Ltd.
3. Hira and Gupta, Operation Research.

SEMESTER - VI

Paper XIII: KBP-S-MAT-3513: Metric Space
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objective: Students should

1. acquire the knowledge of notion of metric space, open sets and closed sets.
2. demonstrate the properties of continuous functions on metric spaces.
3. apply the notion of metric space to continuous functions on metric spaces.
4. understand the basic concepts of connectedness, completeness and compactness of metric spaces

Unit - 1: Limits and metric Spaces **(15)**

Limit of a function on the real line, Metric Spaces definition and examples, Limits in metric spaces

Unit - 2: Continuous functions on metric spaces **(20)**

Functions continuous at a point on the real line, Reformulation, Function continuous on a metric space, Open Sets, Closed Sets

Unit - 3: Completeness and Compactness **(20)**

More about open sets, Bounded sets, totally bounded sets, Complete metric spaces definition and examples, Compact metric spaces, Continuous functions on compact metric spaces.

Unit – 4: Connectedness

Connected Spaces, Path Connected spaces. **(05)**

Learning Outcomes:
After completion, students are able to

1. understand the Euclidean distance function on R^n and appreciate its properties.
2. understand the concept and examples of metric space.
3. explain the definition of continuity for functions.
4. understand the concept of open and closed sets.
5. explain the geometric meaning of each of the metric space properties and be able to verify whether a given distance function is a metric.
6. identify the dense set, Complete metric space, Compact metric spaces.

Recommended Book (Scope of Syllabus):

Scope: Methods of real analysis by R.R. Goldberg John Wiley & Sons 1976.

Unit - 1: Limits and metric spaces Art: 3, 10, 4.1 to 4.3

Unit - 2: Continuous functions on metric spaces Art: 5.1 to 5.5

Unit - 3: Completeness and Compactness Art: 6.1, 6.3, 6.4, 6.5, 6.6

Scope: Topology of Metric Spaces by S. Kumaresan, Alpha Science International Ltd. Harrow, U. K.

Unit – 4: Connectedness Art. 5.1, 5.2

Reference books:

1. A first course in mathematical analysis by D. Somasundaram & B. Choudhary Narosa Publishing House.
2. Mathematical Analysis second edition by S.C. Malik & Savita Arora.
3. Principles of Mathematical analysis by Rudin W. McGraw-Hill, New York.
4. A Course of Mathematical Analysis by Shanti Narayan S. Chand & Company New Delhi. 5. Metric space – Pundir and Pundir.

Paper XIV: KBP-S-MAT-3514: Numerical Analysis
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objectives: Students should

1. analyze the errors obtained in the numerical solution of problems.
2. understand the common numerical methods and how they are used to obtain approximate solutions.
3. derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

Unit - 1: Finite Differences **(15)**

Introduction, Finite differences, Differences of Polynomial, Relation between the operators

Unit - 2: Interpolation **(20)**

Introduction, Newton's forward interpolation formula, Newton's backward interpolation formula, Central difference interpolation formula, Gauss forward interpolation formula, Gauss backward interpolation formula, Stirling's formula, Interpolation with unequal Intervals, Lagrange's Interpolation Formula

Unit - 3: Numerical Differentiation and Integration **(12)**

Numerical differentiation, Formula for derivatives, Maxima and minima of a tabulated function, Numerical Integration, Quadrature formulae (Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8 th rule)

Unit - 4: Difference Equations **(13)**

Introduction, Definitions, Formation of difference equations, Linear difference equation, Rules for finding the Complementary function, Rules for finding the Particular Integral, Difference equations reducible to linear form

Learning Outcomes:
After completion, students are able to

1. apply numerical methods to find the solution of algebraic equations using different methods under different conditions.
2. find the numerical solution of system of algebraic equations.
3. apply various interpolation methods.
4. find numerical solutions.
5. work out numerical differentiation and integration whenever and wherever routine methods are not applicable.
6. apply basic Trapezoidal rule, basic Simpson's 1/3rd rule, basic Simpson's $3/8^{th}$ rule.

Recommended Book (Scope of Syllabus):

Numerical Methods in Engineering & Science with Programs in C and C++ Nineth Edition by B.S. Grewal Khanna Publishers New Delhi.
Chapter – 6: (Finite differences) Art. 1, 2, 3, 7
Chapter – 7: (Interpolation): Art 1, 2, 3, 4, 5, 6, 7, 11, 12
Chapter – 8: (Numerical Differentiation and Integration) Art. 1, 2, 3, 4, 5 (except IV and V)
Chapter – 9: (Difference Equations) Art. 1 to 7.

Reference books:

1. Numerical Analysis and Programming in C by Pundir and Pundir (Pragati Prakashan)
2. Numerical Analysis by P. Kandasamy, K. Thilagavathy, K Gunavathi, S. Chand Publications
3. Introductory Methods of Numerical Analysis by S.S. Sastry and by PHI

Paper XV: KBP-S-MAT-3515: Graph theory
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objective: Students should

1. understands basics of Graph theory, types of graphs.
2. study different operations of graph, connectedness of graph.
3. understand Trees and different types of trees.
4. study number systems and conversion between different number systems.

Unit – 1: Graph Theory **(12)**

Graphs – undirected and directed, simple graphs, multigraphs, degree of vertex, indegree and outdegree of vertex, Types: Null graph, Complete graph, regular graph, platonic, cycles, wheels, Bipartite, complete bipartite, subgraphs, Isomorphic graphs.

Unit – 2: Operations on Graph **(14)**

Union, Intersection, Sum, Ring sum, Complements, product, composition and fusion, Paths, Cycles, cut vertex, cut set, Bridge, Connectedness, Matrix representation, Adjacency matrix, Incidence matrix, Planner graphs, Eulerian and Hamiltonian graphs, Euler's formula.

Unit – 3: Trees **(14)**

Trees and their Properties, Rooted trees, spanning trees, Construction of spanning trees, weighted graphs, Minimal Spanning trees, Tree traversal, Prefix and Postfix notation (Delete binary search tree onward).

Unit – 4: Planarity **(20)**

Planer graph- definition and examples, Examples of non-planer graph, Euler's formula, connected graph, polyhedral graph, simple planer graph, graphs and other surfaces, graph of genus g, Ringel and Youngs theorem, Dual graph, geometric dual of graph G, abstract dual of graph G, relation between abstract duality and planarity of graph, Infinite graphs- basic definitions such as countable graph, locally countable infinite graph, connected locally finite infinite graph, König's lemma, Eulerian graph.

Learning Outcomes:

After completion, students are able to

1. know basics of Graph theory and can differentiate types of graphs.
2. use different operations on graph, can know connectedness of graph.
3. know what is Trees and can differentiate different types of trees.
4. use number systems, and can convert numbers between different number systems.

Recommended Books (Scope of syllabus):

1. **A text book of Discrete Mathematics** by Swapan Kumar Sarkar (S. Chand Co. 1st edition 2003)
   Ch – 13: 13.1 to 13.12 Ch – 14: 41.1 to 14.4
2. **Essential Computer Mathematics** by Seymour Lipschitz, Schaum's outline series
   Ch – 1: 1.1 to 1.3 Ch – 2: 2.1 to 2.4
3. **Introduction to Graph Theory by Robin J. Wilson (Fourth Edition)**
   Ch- 5 Art. 12, 13, 14, 15, 16.

Reference Books:

1. Discrete Mathematics by Dr. Ranjeet Singh, Manish Soni, University Book House (P) Ltd. Jaipur.
2. Discrete Mathematics and Graph theory by Purna Chandra Biswal, PHI, EEE.
3. Introduction to Discrete Mathematics by M. K. Sen, B. C. Chakraborty, Books and Allied (P) Ltd.
4. Fundamental Approach to Discrete Mathematics by D. P. Acharya, Sreekumar, New age Publishers

Paper XVI: KBP-S-MAT-3516: Integral Transforms (Elective - A)
Theory: 60 Lecture.
Marks: 100 (Credits: 04)

Learning Objective: Students should

1. understands the concept Laplace Transform.
2. understands the concept of Inverse Laplace Transform.
3. apply properties of Laplace Transform to solve differential equations.

Unit 1: Laplace Transform. **(20)**

Integral Transform (Definition), Laplace Transform (Definition), Linearity property of Laplace Transform, Piecewise continuous functions, Existence of Laplace Transform, Functions of exponential order, functions of Class A, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Laplace Transform of the derivatives of F(t), Laplace Transform of the $\mathbf{n^{th}}$ order derivatives of F(t), Initial value theorem, Final value theorem, Laplace Transform of Integrals, Multiplication by t, Multiplication by $\mathbf{t^n}$, Division by t, Evaluation of Integrals, periodic functions.

Unit 2: The Inverse Laplace Transform. **(20)**

Inverse Laplace Transform, Null Function, Linearity Property, Table of Inverse Laplace Transform, First Translation or Shifting Theorem, Second Translation or Shifting Theorem, Change of Scale Property, Use of Partial function, Inverse Laplace Transform of the derivatives, Inverse Laplace Transform of Integrals, Multiplication by powers of p, Division by powers of p, Convolution (definition), Convolution theorem, Heaviside's expansion formula, Beta function.

Unit 3: Application of Laplace Transforms. **(20)**

Ordinary Differential equations with constant coefficients, Ordinary Differential equations with variable coefficients, Simultaneous ordinary differential equations, Partial differential equations.

Learning Outcomes:

After completion, students are able to

1. recognize the different methods of finding Laplace transforms
2. calculate inverse Laplace by using different methods and use of first shifting theorem and Second shifting theorem
3. solve the differential equations by using Laplace and inverse Laplace

Recommended Books:

Integral Transform by Vasishta A. R. Gupta, R. K. Krishna Prakashan Media Pvt. Ltd. 11. Shivaji Road, Meerut India.

Unit 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 1.13,1.14, 1.15, 1.16, 1.17, 1.18, 1.19, 1.20, 1.21
Unit 2: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13,2.14, 2.15, 2.16, 2.17
Unit 3: 3.1, 3.2, 3.3, 3.4

Reference Books:

1. The Laplace Transform by Rainville E.D.
2. Integral Transform by Dr. J.R. Goyal and K.P. Gupta, Pragati Prakashan Meerut.
3. Differential equation by Sharma and Gupta, Krishna Prakashan Media Co. Meerut
4. Integral Transform and their Applications by Lokenath Debnath, CRC Press.
5. An introduction to Laplace Transforms and Fourier series by Phill Dyke, Springer publication.

Paper XVI: KBP-S-MAT-3516: Programming in C (Elective - B)

Theory: 60 Lecture.

Marks: 100 (Credits: 04)

Learning Objective: Students should

1. understand the Basics of Programming C.
2. study Constants, variable, data type, operators, and expressions.
3. understand Managing input and output operators, decision making, branching and looping
4. study Arrays and user defined functions

Unit 1: Overview of C. **(10)**

Introduction, Importance of C, Sample C programs, Basic structure of C programs, programming style, executing a C program, Points to remember, Introduction of user - defined functions, need for user - defined functions, A multifunction programs, The form of C Functions, Return values and their types

Unit - 2: Constants, Variables and Data Types **(10)**

Introduction, Character Set, C Token, Constants, Keywords and Identifiers, Variables, Data Types, Declaration of variables, assigning values to variables, Defining symbolic constants

Unit - 3: Operators, Expressions and Managing Input, Output Operators **(25)**

Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increments and decrement operators, Conditional operators, Bit-wise operators, special operators, Arithmetic expressions, Evaluation of expressions, Precedence of arithmetic operators, Some computational problems, Type conversions in expressions, Operators precedence and associativity, Mathematical functions, Introduction, Reading a character, Writing a character, Formatted input, Formatted output

Unit - 4: Decision Making, Branching, Looping and Arrays **(15)**

Introduction, Decision making with IF statement, Simple IF statements, The IF...ELSE Statement, Nesting of If.... ELSE Statement, The ELSE.... IF ladder, The SWITCH Statement, The? Operator, The GOTO statement, Introduction, The WHILE Statement, The DO Statement, The FOR Statement, jumps in loops, Introduction of Arrays, one dimensional array, two dimensional arrays, Initializing two dimensional arrays, Multidimensional arrays

Learning Outcomes:

After completion, students are able to:

1. know the Basics of Programming C.
2. identify Constants, variable, data type, operators, and expressions.
3. use Managing input and output operators, decision making, branching and looping.
4. use Arrays and user defined functions

Recommended Book (Scope of Syllabus):

1. Programs in C by E. Balgurusamy, McGraw Hill, New-Delhi

Unit 1: 1.1- 1.7
Unit 2: 2.1- 2.10
Unit 3: 3.1- 3.16
Unit 4: 4.1-4.5
Unit 5: 5.1 - 5.9

Unit 6: 6.1 - 6.5
Unit 7: 7.1- 7.5
Unit 8: 8.1 - 8.5

Reference Books:

1. Numerical Methods in Engineering & Science with Programs in C and C++ Nineth Edition by B.S. Grewal Khanna publishers New Delhi.
2. Numerical Analysis and Programming in C by Pundir and Pundir (Pragati Prakashan)
3. A Book on C, Macmillan, by Berry, R.E. and Meekings.
4. C Programming Language: An applied perspective, John Wiley & Sons
5. The C Programming Tutor, Prentice-Hall, by Wortman, L.A. and Sidebottom.
6. C made Easy, Osbone McGraw-Hill by Schildt, H.C.
7. Let us C by Yashwant Kanetkar BPB Publications, New-Delhi.
8. Programming in C by Schaum's Outline Series, Tata McGraw Hill, EEE.

Paper Code: KBP-S-MAT-36-SC: Skill Enhancement Course
Course Title: Quantitative Aptitude
Marks: 100 (Credits: 04)

Learning Objective: Students should

1. able to enhance the problem-solving skills

2. to improve basic mathematical skills for competitive examinations.

Unit I: Numbers & their H.C.F., L.C.M., Percentages, Ratio, Proportion, Partnership **(17)**

Classification of Numbers, Test of Divisibility, Conversion of the recurring decimals into the fractions, Test for Prime Numbers, Prime factorizations, Method to find the Number of divisors and sum of the divisors of a number, Remainder theorem and Method to find the digit at the unit's place, Problems on Numbers, Method to find the HCF and LCM, Problems on the HCF and LCM, Theory about the percentages, Problems on the percentage, Mixtures and Allegations, Problems on both, Theory of Partnership, To find the ratio of the profit and period of investment, Problems

Unit II: Averages, Profit and Loss, Time, Speed and Distance, Time and Work, and Pipes and Cistern **(15)**

Types of the Averages, Problems on the Averages, Theory of Profit and Loss, to find the percentage of profit and loss, to calculate the CP and SP, Problems, Theory of the time, Speed and Distance, Theory of Trains, Boats and Streams, to calculate the CP and SP, Problems, Theory of Work, Ratio of works and Time, Problems

Unit III: Permutations and Combinations, Probability, Simple and Compound Interest, Logical Ability **(15)**

Theory and Formulae of Permutation and Combination, Problems, Theory and formulae of Probability, Problems, Formulae to find the Simple and Compound interest, to find the Amount, Rate of interest and period, Problems, Tricky questions from various entrance examinations

Unit IV: Clock, Calendar, Data Interpretation, Odd Man Out and Series **(13)**

Theory and formulae of Clock, Problems, Theory and formulae of Calendar, Problems, Theory and formulae of Bar graph, Pie chart, Line graphs and Tabulation, Problems

Learning Outcomes:
After completion, students are able to:

- draw conclusion and / or make decisions based on analysis and critique of quantitative information using proportional reasoning.
- justify and communicate their conclusions in ways appropriate to the audience.

Reference Books:

1) Quantitative Aptitude for competitive examinations by Dr. R. S. Aggarwal, S. Chand.
2) Quantitative Aptitude for competitive examinations by Abhijit Guha.

Numerical Technique Laboratory [NTL-III(A) to III(D)]

Note: Each assignment is of 1.5 periods [50+25 = 75 minutes]

NTL-III(A) (Algebra - II + Metric Spaces)

(Problems on the following topics)

Section - I: Algebra - II

Assignment-1: Rings and subrings, Integral domains and Fields

Assignment-2: Isomorphism and Characteristic of rings.

Assignment-3: Homomorphisms of Rings. Ideals, Quotient Rings

Assignment-4: Subspaces, Liner Dependence, independence and basis

Assignment-5: Linear transformation and matrices, Kernel and range

Assignment-6: Inverse and Composite of linear transformation, Inner Product Space

Section - II: Metric Spaces

Assignment-7: Metric Space-I (Examples on Metric spaces, open set, closed set, boundary set in Metric spaces)

Assignment-8: Metric Space-II (Examples on bounded set, totally bounded set and Diameter of set in Metric spaces)

Assignment-9: Metric Space-III (Examples on Limit of metric space, Cauchy sequence in Metric spaces)

Assignment-10: Metric Space-IV (Contraction, Isometry, homeomorphism in Metric spaces)

Assignment-11: Metric Space-V (Examples on cover, open cover, Dense in Metric spaces)

Assignment-12: Metric Space-VI (Examples on completeness and compactness in Metric Spaces)

NTL-III(B) (Complex Analysis + Numerical Analysis)

(Problems on the following topics)

Section - I: Complex Analysis

Assignment-1: Find the regular (analytic) function (real, Imaginary, u+v, u-v type.)

Assignment-2: Solving the complex integration along Circle, Line and Parabola.

Assignment-3: Obtain the Taylor's and Laurent's series.

Assignment-4: Calculus of residue.

Assignment-5: Integration around the unit circle.

Assignment-6: Evaluation of integral S $^{2p}_{|}$(cosq, sinq)dq.

Section- II: Numerical Analysis

Assignment-7: Finite Differences

Example on Forward, Backward and Central difference formulae, Differences of a Polynomial, Relation between operators, (Forward (D), Backward (Ñ), Central d, Shift (E))

Assignment-8: Interpolation-I

Examples on Newton's forward difference formula, Newton's backward difference formula, Central difference formula

Assignment-9: Interpolation-II

Examples on Gauss's forward and backward difference formulae, Stirling's formula, Lagrange's interpolation formula

Assignment-10: Numerical Differentiation

Examples on Numerical differentiation, formula for derivatives, maxima and minima of tabulated function

Assignment-11: Numerical Integration

Examples on Numerical integration, Trapezoidal rule, Simpson's $1/3^{rd}$ Rule and Simpson's $3/8^{th}$ rule.

Assignment-12: Difference Equations

Examples on Formation of difference equations, Linear difference equation, finding to Complementary function, finding the Particular Integral, Difference equations reducible to linear form.

NTL-III(C) (Integral Calculus +Graph Theory)

Section - I: Integral Calculus

Assignment-1: Improper Integral – I
Assignment-2: Improper Integral – II
Assignment-3: Beta and Gamma function - I
Assignment-4: Beta and Gamma function - II
Assignment-5: Multiple integrals - I (change of order Change of Variable)
Assignment-6: Multiple integrals - II (Area and Volume)

Section – II: Graph Theory

Assignment-7: Operations on graph
Assignment-8: Adjacency and incidence matrix (with graphs)
Assignment-9: Spanning tree and Minimum spanning tree
Assignment-10: Infix/Prefix and postfix and their tree
Assignment-11: Conversion of decimal to binary/octal/Hexadecimal.
Assignment-12: Conversion of binary/octal/Hexadecimal to decimal

NTL-III (D)
(Partial Differential Equation OR Operation Research + Integral Transform OR Programming in C)

Section – I: Partial Differential Equations

Assignment-1: Solve linear differential equation of first order by arbitrary constant and arbitrary function, Lagrange's method.

Assignment-2: Nonlinear partial differential equation of order one by Charpit's method.

Assignment-3: Find C.F. for Homogeneous linear partial differential equation with constant coefficient.

Assignment-4: Solve examples on certain standard form I, II, III, IV

Assignment-5: Find C.F. and P.I. for Non-Homogeneous linear partial differential equation with constant coefficient.

Assignment-6: Find C.F. and P.I. for equation reducible to linear differential equation with constant coefficient.

OR

Section- I: Operation research

Assignment-1: Solve the given LLPs by graphical method.

Assignment-2: Solve the given LLPs by simplex method.

Assignment-3: Examples on M-method, two phase method.

Assignment-4: Examples on Northwest-corner Method, least cost method, Vogel Approximation Method

Assignment-5: Find optimal solution of given two-person zero Sum games.

Assignment-6: Examples on graphical solution of games, linear programming solution of games.

Section- II: Integral Transform

Assignment-7: Laplace Transforms (Numerical examples)

Assignment-8: Inverse Laplace Transform (Numerical Examples)

Assignment-9: Examples on First Translation/Shifting Theorem, Second Translation/Shifting Theorem,

Assignment-10: Examples on Inverse Laplace Transform of the derivatives, Inverse Laplace Transform of Integrals

Assignment-11: Examples on Convolution theorem, Heaviside's expansion formula.

Assignment-12: Examples on to find the solution of ordinary differential equation with constant or variable coefficients by using Laplace Transform.

OR

Section- II: Programming in C

Assignment No.7: Sample Programs – I:

Addition, subtraction, multiplication and division, Area, Volume of a sphere, Temperature Conversion, Simple Interest Calculation, Compound Interest Calculation, Salary Calculation, Bonus and Commission.

Assignment No.8: Sample Programs – II:

Star pattern, Reverse of a given number, Fibonacci sequence, Factorial ${}^{n}C_{r}$, ${}^{n}P_{r}$, Roots of the quadratic equation.

Assignment No.9: Sample Programs – III:

Maximum and Minimum, Sum of the series $1+2+3+\ldots\ldots+n$, $1^2+2^2+3^2+\ldots.+n^2$, $1^3+2^3+3^3+\ldots\ldots+n^3$, $1^2+3^2+\ldots.+(n-1)^2$, $2^2+4^2+6^2+\ldots+(2n)^2$

Assignment No.10: Sample Programs – IV: Sine, Cosine, Exponential series

Assignment No.11: Sample Programs - V:

Ascending and descending data. Matrix addition/Subtraction, Matrix multiplication.

Assignment No.12: Sample Programs – VI:

Trapezoidal Rule, Simpson's $1/3^{rd}$ Rule, Simpson's $3/8^{th}$ Rule.

Bekar

Chairman
Board of studies, Mathematics
Karmaveer Bhaurao Patil Mahavidyalya, pandharpur.