

**Modern Education Society's  
Nowrosjee Wadia College  
(AUTONOMOUS)**



**NAAC Accredited A+ with CGPA  
3.51**

Affiliated to the  
**Savitribai Phule Pune University**  
*(Formerly University of Pune)*

**Three Year B. Sc. Degree Program in Mathematics  
(Faculty of Science & Technology)**

**B. Sc. (Mathematics)**

**National Education Policy (NEP) Syllabus  
To be implemented from Academic Year 2026-2027**

### 1. Preamble of the Syllabus

In compliance with the directives from the University Grants Commission, under the autonomous status of the college, the syllabus for Mathematics at the undergraduate level is revised and reframed as per the National Educational Policy (NEP 2020) curriculum framework. Nowrosjee Wadia College has decided to change the syllabi for the degree of B. Sc. from June 2023, as the college has already shifted to the autonomous status from the academic year 2022-2023. The present syllabus is prepared by the Board of Studies in Mathematics, Nowrosjee Wadia College, taking into consideration the present relevance and application of the various branches of Mathematics. While preparing this syllabus the U.G.C. model curriculum (LOCF) and existing syllabus given by Savitribai Phule Pune University is followed.

### 2. Objectives

- To create deep interest in learning mathematics.
- Develop broad and balanced knowledge and understanding of definitions, concepts, principles.
- Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
- Enhance the ability of learners to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics.
- Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.
- Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

### 3. Programme Outcomes

- Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science and statistics. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics.
- The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilised in modelling and solving real life problems.
- Students undergoing this programme learn to logically question assertions, to recognise patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society.
- Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.
- Completion of this programme will also enable the learners to join teaching profession in primary and secondary schools.

## T. Y. B. Sc. Mathematics Syllabus for NEP 2.0

- This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

### 4. Eligibility

Higher secondary school certificate (10+2) (Science) or its equivalent examination in Maharashtra State or any other States in India with equal qualifications are eligible for admission to the course.

### 5. Duration of the Course:

The duration of the B.Sc. Mathematics Program shall extend over 6 semesters (three academic years) of 15 weeks or more, each with a maximum of 90 actual working days of instruction in each semester.

### 6. Medium of instruction:

The medium of instruction shall be English.

### 7. Teaching Scheme:

- The course is a 3 year, 6 semesters full time under graduate course.
- The course follows the NEP (National Educational Policy 2020) pattern as per
- *Government of Maharashtra G.R(s) as follows:*

सांकेतांक २०२३०४२०१९२५२६६९०८

शासन निर्णय क्रमांक: एनईपी-२०२२/प्र.क्र.०९/विशि-३ शिकाना, दिनांक २० एप्रिल, २०२३

4 credit theory course = 60 hours (60 lectures)

2 credit theory courses = 30 hours (30 lectures)

2 credit practical course = **60 hours (4 hours/ week/ batch)**

### 8. Abbreviations

OE: Open Elective

AEC: Ability Enhancement Course

VEC: Value Education Courses

CC: Co-Curricular Courses

IKS: Indian Knowledge System

OJT: On Job Training

FP: Field Project

VS: Vocational Skill Courses

CEP: Community Engagement Project

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T: Theory

P: Practical

CE: Continuous Evaluation

SEE: Semester End Examination

F.Y.: First Year

S.Y.: Second Year

T.Y.: Third Year

## T. Y. B. Sc. Mathematics Syllabus for NEP 2.0

Board of Studies in Mathematics, Modern Education Society's Nowrosjee Wadia College, Pune															
Proposed Credit Structure for Level 4.5-8 as per Govt. of Maharashtra through GR शासनननर्णयक्रमााांक:एनईपी-२०२२/प्र.क्र.०९/विशेश-३शशकाना,विनााांक३३मार्ण,२०२४)															
Year/ Level	Sem.	Subject-I			Subject-II		Subject-III							Total	
		V-1	V-4	V-6	V-2	--	V-3	V-5	V-4	V-5	V-5	V-6	V-6		
		Major	Elective	VSC	OJ T/FP	Minor	-	OE/GE	IKS	SEC	AEC	VEC	CC	RP	
1 Yr./ 4.5	I	2(T)+2(T/P)=4 <b>NMT-101-T:</b> Algebra (2T) <b>NMT-102-P:</b> Practical Based on NMT-101 (2P)	--	--	--	2(T)+2(T/P)=4	2(T)+2(T/P)=4	2(T) OE101 NMT: Analytical Ability I (Other Faculty)	2 IKS101 NMT: Generic IKS	2(P) SEC-101 NMT: Python-I	2 AEC101 EN G: English Communication	2 VEC101 EN V: Environmental Studies	--	--	22
	II	2(T)+2(T/P)=4 <b>NMT-151-T:</b> Single Variable Calculus (2T) <b>NMT-152-P:</b> Practical Based on NMT-151 (2P)	--	--	--	2(T)+2(T/P)=4	2(T)+2(T/P)=4	2(P) OE151 NMT: Analytical Ability II (Other Faculty)	--	2(P) SEC-151 NMT: Python-II	2 AEC151 EN G: English Communication	2 VEC151 EN V: Environmental Studies	2 CC151 (PE/NSS/NCC)	--	22
2 Yr./ 5.0	III	4(T)+2(P)=6 <b>NMT-201MJ:</b> Calculus of Several Variables (T) <b>NMT-202MJ:</b> Laplace Transforms (T) <b>NMT-203MJP:</b> Practical Based on NMT201 & NMT 202 (P)	--	2 NMT-221 VSC Foundations of Mathematics (T)	2 MT S-231 FP	2(T)+2(P)=4 <b>NMT241 MN</b> Numerical Methods & <b>NMT242 MN</b> Practical Based on NMT241 MN	--	2 OE201 NMT: (Other Faculty)  Quantitative Ability I	2 IKS101 NMT: IKS Mathematics in Ancient India	--	2 AEC201: M L :ENG/MAR/ HIN (T)	--	2 CC201 (PE/NSS/NCC)	--	22

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	IV	4(T)+2(P)=6 <b>NMT-251MJ:</b> Linear Algebra (T) <b>NMT-252MJ:</b> Vector Calculus (T) <b>NMT-254MJP:</b> Practical Based on NMT251 & NMT252 (P)	--	2 <b>NMT-271 VSC</b> Practical Based on Mathematics with Data Science	2 NMT-281 CEP	2(T)+2(P)=4 <b>NMT291MN</b> Laplace Transforms & <b>NMT292MN</b> Practical Based on NMT291MN	--	2(P) OE 251 NMT: (Other Faculty) Quantitative Ability II		2 <b>SEC-251NMT:</b> Latex (P)	2 AEC251: MIL :ENG/MAR/HIN (T)	--	2 CC251 (PE/NSS/NCC)	22
3 Yr./ 5.5	V	8(T)+4(P)=12 <b>NMTMJ-351:</b> Real Analysis I <b>NMTMJ-352</b> Group Theory (T) <b>NMTMJ-353</b> Metric Spaces (T) <b>NMTMJ-354</b> Ordinary Differential Equations (T) <b>NMTMJ-355 :</b> Practical Based on 351 and 352 <b>NMTMJ-356:</b> Practical Based on NMT- 353 and 354	2(T)+2(T/P)=4 <b>NMTMJ-3510:</b> (A) Numerical Analysis (T) OR (B) Operations Research (T)  <b>NMTMJ-3511:</b> Practical based on NMT-3510 (A/ B)	2 <b>NMTVSC-3521 :</b> Mathematical Statistics (P)	2 NMT-331 FP/ CEP	2(T/P)=2 <b>NMTMN351</b> Introduction to Computational Geometry(P)	-							22



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<b>VIII</b>	<p>10(T) + 4(P) = 14</p> <p><b>NMT-381MJ:</b> Advanced Calculus (T) (4)</p> <p><b>NMT-382MJ:</b> Field Theory (T) (4)</p> <p><b>NMT-383MJP:</b> Practical Based on NMT-381 &amp; 382 (P) (4)</p> <p><b>NMT-382MJ:</b> Integral Equations (T) (2)</p>	<p>2(T)+2(T/P)=4</p> <p><b>NMT-380MJ:</b> A) Functional Analysis II (T) (2) OR B) Commutative Algebra II (T) (2)</p> <p><b>NMT-381MJP:</b> Practical based on NMT-380 (A/B) (P) (2)</p>		<b>OJT (4)</b>											22
<b>Total</b>	72	16	8	14	22	8	8	4	6	8	4	6	6	6	176

## Semester – V

### NMTMJ 351: Real Analysis-I (Major) (2 credits)

**Course Objectives:** The course will provide students with a thorough understanding of real lines and distinguishing concepts in order to prove convergence and divergence of real number sequences and series. These principles have a wide variety of real-world applications.

**Course Learning Outcomes: -**

This course will enable the students to:

CO1: Learn the basic facts in logic and set theory

CO2: Learn to define sequence in terms of functions from  $\mathbb{N}$  to a subset of  $\mathbb{R}$  and to understand several properties of the real line.

CO3: Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.

CO4: Use the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

#### Course Contents

##### Unit 1: Sequences of Real Numbers

[8 Lectures]

1.1 Definition of sequence and subsequence

1.2. Limit of a sequence

1.3 Convergent sequences

1.4 Divergent sequences

1.5 Bounded sequences

1.6 Monotone sequences

##### Unit 2: Operations on convergent sequences and

[8 Lectures]

##### Limit Superior, Limit Inferior

2.1 Operations on convergent sequences

2.2 Operations on divergent sequences

2.3 Limit superior and limit inferior

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2.4 Cauchy sequences

### **Unit 3: Series of Real Numbers**

**[14 Lectures]**

3.1 Convergence and divergence

3.2 Series with nonnegative terms

3.3 Alternating series

3.4 Conditional convergence and absolute convergence

3.5 Tests for absolute convergence

3.6 Series whose terms form a non-increasing sequence

3.7 The Class  $l^2$

### **Text Books: -**

1. Methods of Real Analysis, Second Edition, Richard R. Goldberg, John Wiley & Sons, Inc.

Unit 2: Chapter 2: Sec.: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6,

Unit 3: Chapter 2: Sec.: 2.7, 2.8, 2.9, 2.10,

Unit 4: Chapter 3: Sec.: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.10

### **Reference Books: -**

1. Real Analysis, N.L. Carothers, Cambridge University Press

2. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbert, John Wiley and Sons.

3. A Basic Course in Real Analysis, Ajit Kumar and S. Kumaresan, CRC Press, Second Indian, CRC Press (Chapman and Hall)

4. A course of Mathematical Analysis, Revised edition, Shantinayakan and Mittal - S. Chand and Co. (2002).

5. Mathematical Analysis, third Edition, S.C. Malik and Savita Arora - New Age International Publications

**NMTMJ-352: Group Theory (Major) (2 Credits)**

**Course Specific Outcomes: -**

This course will enable the student to:

- CO1: Recognize the mathematical objects that are groups and classify them as abelian, cyclic and permutation groups etc.
- CO2: Analyse consequences of Lagrange's theorem.
- CO3: Learn about structure preserving maps between groups and their consequences.
- CO4: Explain the significance of the notion of cosets, normal subgroups and factor groups.

**Course Content**

<b>Unit 1: Groups</b>	<b>[5 Lectures]</b>
1.1 Binary Operations	
1.2 Groups	
1.3 Direct Product of Groups	
<b>Unit 2: Subgroups and Theorem of Lagrange</b>	<b>[5 Lectures]</b>
2.1 Subgroups	
2.2 Cyclic Groups	
2.3 Cosets and the Theorem of Lagrange	
<b>Unit 3: Permutation Groups</b>	<b>[10 Lectures]</b>
3.1 Groups of Permutations	
3.2 Orbits	
3.3 Cycles	
3.4 Alternating Groups	
<b>Unit 4: Homomorphisms and Factor Groups</b>	<b>[10 Lectures]</b>
4.1 Homomorphisms, Isomorphisms	
4.2 Quotient Groups	
4.3 Fundamental Theorem of Group Homomorphism	

**Textbook: -**

John B. Fraleigh, A First Course in Abstract Algebra, Seventh Edition, Pearson.

Sections: 2, 3, 4, 5, 6, 8, 9, 10, 11 (only Direct Product) 13, 14, 15.

## **T. Y. B. Sc. Mathematics Syllabus for NEP 2.0**

### **Reference Books: -**

1. A Course in Abstract Algebra, 5th Edition, by V. K. Khanna & S. K. Bhambri, Vikas Publishing House, 2016.
  - I. N. Herstein, Topics in Algebra, John Wiley and Sons.
2. Joseph A. Gallian, Contemporary Abstract Algebra, (4th Edition), Narosa Publishing House.
3. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Edition, John Wiley and Sons, Inc.

**NMTMJ-353: Metric Spaces (Major) (2 Credits)**

**Course specific outcomes: -**

This course will enable the students to:

- CO1: Understanding Metric Spaces – Define and explain the concept of a metric space, including examples and counter examples.
- CO2: Analyse open and closed sets, interior, closure, and boundary of sets in metric spaces.
- CO3: Convergence and Continuity – Understand sequences in metric spaces, limits, and continuity of functions.
- CO4: Explain Cauchy sequences, completeness.
- CO5: Identify and analyse homeomorphisms and isometries in metric spaces.
- CO6: Compactness and Connectedness – Define and characterize compact and connected metric spaces with relevant theorems and proofs.

**Course Content**

<b>Unit 1: Basic Notation</b>	<b>[8 Lectures]</b>
1.1 Definition and Examples	
1.2 Open balls and Open sets	
<b>Unit 2- Convergence</b>	<b>[6 Lectures]</b>
2.1 Convergent Sequences	
2.2 Limit and Cluster points	
2.3 Cauchy Sequences and Completeness	
2.4 Bounded Sets	
2.5 Dense Sets	
2.6 Boundary of a set	
<b>Unit 3- Continuity</b>	<b>[8 Lectures]</b>
3.1 Continuous Functions	
3.2 Equivalent Definitions of Continuity	
3.3 Topological Property	
3.4 Uniform Continuity	
3.5 Limit of a Function	

**Unit 4- Compactness and Connectedness**

**[8 Lectures]**

4.1 Compact Spaces and their Properties

4.2 Connected Spaces

**Textbooks: -**

1. Topology of Metric Spaces, S. Kumaresan, Narosa Publishing House (2nd edition), 2011.

Unit 1: Chapter 1; 1.1 to 1.2 (Except theorem's .1.14,1.1.15,1.1.21,1.1.35,1.1.36,1.1.37)

Unit 2: Chapter 2; 2.1 to 2.5 (Except theorem's- 2.2.28, 2.3.12, Lemma 2.5.6), 2.7

Unit 3: Chapter 3; 3.1 to 3.5 (Except theorem's-3.2.33, 3.2.46, 3.2.49, 3.4.10)

Unit 4: Chapter 4; 4.1 to 4.39 Except theorem's- Lemma 4.1.28,4.2.13,4.3.14,4.3.24),

Chapter 5; 5.1

**Reference Books: -**

1. Metric Spaces, Q.H. Ansari: Narosa Publishing House, New Delhi, Chapters 1 – 5.
2. Metric Spaces, Satish Shirali, H. Vasudeva, Springer.
3. First Course in Metric Spaces, B. K. Tyagi, Cambridge University Press
4. M. O. Searcoid: Metric spaces, Springer, 2007.

## NMTMJ-354: Ordinal Differential Equations (Major) (2 credits)

### Course specific outcomes: -

This course will enable the students to:

CO1: Understand the genesis of ordinary differential equations.

CO2: Learn various techniques and methods to solve differential equations.

### Course Content

<b>Unit 1. Linear Differential Equations with constant coefficients</b>	<b>[8 Hours]</b>
1.1 Constant coefficient homogeneous equations	
1.2 Characteristic equations	
1.2.1 Distinct real roots	
1.2.2 repeated roots	
1.2.3 complex roots	
<b>Unit 2. Non -Homogeneous Linear Equations</b>	<b>[8 Hours]</b>
2.1 Method of undetermined coefficients	
2.2 Method of reduction of order	
2.3 Method of variation of parameters.	
<b>Unit 3. Inverse differential operator</b>	<b>[6 Hours]</b>
3.1 The operator $1/(D)$ and its evaluation for the functions $x^m, e^{ax}, e^{ax}x^v, x^v$ .	
3.2 The operator $1/(D^2+a^2)$ acting on $\sin ax$ and $\cos ax$ with proofs.	
<b>Unit 4. System of Equations</b>	<b>[4 Hours]</b>
4.1 Introduction to system of differential equations	
4.2 Solution of homogeneous first order systems with constant coefficient	
<b>Unit 5. Power Series Solutions</b>	<b>[4 Hours]</b>
5.1 Review the properties of power series	
5.2 Classifications of ordinary and Singular points	
5.3 Series solution near an ordinary point	

## **T. Y. B. Sc. Mathematics Syllabus for NEP 2.0**

### **References: -**

1. Elementary Differential Equations seventh edition by Earl D. Rainville and Philip E Bedient. Chapter-6, 33 to 37. Chapter-7, 41. Chapter-8, 44 to 45, Chapter-9, 47 to 50. Chapter-13, 76 to 81. Chapter-17, 105 to 107.
2. William F Trench, Elementary Differential Equations with Boundary Value Problems, E book (Free download)
3. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand and Company LTD 2009.

**NMTMJ-355: Practical Based on 351 and 352**

**Practicals Based on Real Analysis I** [30 Lectures]

Practical 1: Sequences

Practical 2: Subsequence's and convergent sequences

Practical 3: Problems on monotone convergence theorem

Practical 4: Operation on convergent sequences

Practical 5: Series of real numbers-I (4.1 to 4.3)

Practical 6: Series of real numbers-II (4.4 to 4.7)

**Practicals Based on Group Theory** [30 Lectures]

**NMTMJ-356: Practical Based on 353 and 354**

**Practicals Based on Metric Spaces** [30 Lectures]

**Practicals Based on Ordinary Differential Equations** [30 Lectures]

**NMTMJ-3510(A): Numerical Analysis (Elective) (2 Credits)**

**Course specific Outcomes:** This course will enable the student to:

1. Understand and apply numerical methods to solve algebraic and transcendental equations, including bisection, false position, and Newton-Raphson methods, with an emphasis on error analysis and convergence.
2. Apply interpolation techniques for estimating intermediate values
3. Utilize numerical integration methods such as the trapezoidal rule, Simpson's one-third rule, and Simpson's three-eighth rule to approximate definite integrals.
4. Solve ordinary differential equations numerically using Euler's method, Euler's modified method, and Runge-Kutta methods.

**Unit 1: Errors in Numerical Calculations** **[3 Lectures]**

- 1.1 Errors and their computations
- 1.2 A general error formula

**Unit 2 : Solution of Algebraic and Transcendental Equations** **[7 Lectures]**

- 2.1 Bisection method.
- 2.2 The method of False position.
- 2.3 The iteration method
- 2.4 Newton- Raphson method.
- 2.5 Gauss- Seidel method

**Unit 3: Interpolation** **[7 Lectures]**

- 3.1 Finite Difference Operators and their relations.
- 3.2 Differences of a polynomial
- 3.3 Newton's Interpolation Formulae (Forward and Backward )
- 3.4 Lagrange's Interpolation Formula

**Unit 4: Numerical Differentiation and Integration:** **[8 Lectures]**

- 4.1 Numerical Differentiation
- 4.2 Numerical Integration, General quadrature formula.
- 4.3 Trapezoidal rule.
- 4.4 Simpsons's  $\frac{1}{3}$ rd rule.
- 4.5 Simpsons's  $\frac{3}{8}$ th rule.

**Unit 5: Numerical solution of first order ordinary differential equations:** **[5 Lectures]**

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5.1 Euler's method.

5.2 Modified Euler's methods.

5.3 Runge - Kutta Methods.

### **Text book: -**

**S. S. Sastry, Introductory Methods of Numerical Analysis, 5<sup>th</sup> edition, Prentice Hall of India.**

Unit 1: Chapter 1: section 1.3, 1.4

Unit 2: Chapter 2: section 2.2, 2.3, 2.4, 2.5, Chapter 7: section 7.6

Unit 3: Chapter 3: section 3.3, 3.5, 3.6, 3.9(3.9.1 only)

Unit 4: Chapter 4: section 6.2(6.2.3 only), 6.4

Unit 5: Chapter 5: section 8.4 (excluding 8.4.1).

### **Reference Books: -**

1. C.F. Gerald and O.P. Wheatley, Applied Numerical Analysis, Addison Wesley; 7<sup>th</sup> edition (2003).
2. K.E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.
3. T. Sauer, Numerical analysis, 3<sup>rd</sup> edition, Pearson.
4. M. K. Jain, SRK Iyengar and R.K. Jain, Numerical Methods For Scientific & Engg 5e, New Age International (P) Ltd (2008).

## **NMTMJ-3511(A): Practical Based on 3510 (Elective) (2 Credits)**

Practicals Based on 3510(A): Numerical Analysis

**[60 Hours]**

**NMTMJ-3510(B): Operations Research (Elective) (2 Credits)**

**Course specific outcomes: -**

This course will enable the student to:

CO1: Analyse and solve linear programming models of real-life situations.

CO2: Provide graphical solution of linear programming problems with two variables, and illustrate the concept of convex set and extreme points.

CO3: Solve linear programming problems using simplex method.

CO4: Learn techniques to solve transportation and assignment problems.

**Course Content**

**Unit-1: Linear Programming Problem, Convexity and Basic Feasible Solutions** [10 Lectures]

- 1.1 Formulation of LPP
- 1.2 Canonical and Standard forms
- 1.3 Graphical solution
- 1.4 Convex and polyhedral sets, Extreme points
- 1.5 Basic solutions, Basic Feasible Solutions
- 1.6 Correspondence between basic feasible solutions and extreme points.

**Unit 2: Simplex Method** [10 Lectures]

- 2.1 Optimality criterion
- 2.2 Improving a basic feasible solution
- 2.3 Unboundedness; Simplex algorithm and its tableau format
- 2.4 Artificial variables, Two-phase method
- 2.5 Big-M method.

**Unit 3: Transportation and Assignment Problems** [10 Lectures]

- 3.1 Methods of finding initial basic feasible solutions:  
North-west corner rule, least cost method, Vogel approximation method,
- 3.2 Algorithm for obtaining optimal solution
- 3.3 Assignment problems
- 3.4 Hungarian method.

## **T. Y. B. Sc. Mathematics Syllabus for NEP 2.0**

### **Textbook: -**

Hamdy A. Taha (2017). Operations Research: An Introduction (10th edition). Pearson.

### **References: -**

- 1 G. Hadley (2002). Linear Programming. Narosa Publishing House.  
UGC DOCUMENT ON LOCF MATHEMATICS 91
- 2 Frederick S. Hillier & Gerald J. Lieberman (2015). Introduction to Operations Research (10th edition). McGraw-Hill Education.
- 3 Paul R. Thie & Gerard E. Keough (2014). An Introduction to Linear Programming and Game Theory (3rd edition). Wiley India Pvt. Ltd

### **NMTMJ-3511(B): Practical Based on 3510(B) (Elective) (2 Credits)**

Practicals Based on NMT-311MJP(B): Operational Research

**[60 Lectures]**

### **NMTVSC-3521: Mathematical Statistics (2 Credits)**

Practicals Based on Mathematical Statistics

**[60 Lectures]**

**NMTMN-351: Practical Based on Introduction to Computational Geometry (Minor) (2 Credits)**

**Course specific outcomes: -**

This course will enable student to:

CO1: Gain knowledge of the problems that can be solved using computation geometry

CO2: Understand general techniques for solving problems within computational geometry

CO3: Understand the concept of algorithms in computational geometry

**Course Content**

**Unit 1: Two Dimensional Transformations [8 Hours]**

- 1.1 Introduction.
- 1.2 Representation of points.
- 1.3 Transformations and matrices.
- 1.4 Transformation of – points, straight lines.
- 1.5 Midpoint Transformation.
- 1.6 Transformation of – parallel lines, intersecting lines.
- 1.7 Transformation: rotations, reflections, scaling.
- 1.8 Combined transformations.
- 1.9 Transformation of a unit square.
- 1.10 Solid body transformations.
- 1.11 Translations and homogeneous coordinates.
- 1.12 Rotation about an arbitrary point.
- 1.13 Reflection through an arbitrary line.
- 1.14 Projection – A Geometric Interpretation of Homogeneous Coordinates.
- 1.15 Overall Scaling.
- 1.16 Points at Infinity.

**Unit 2: Three Dimensional Transformations [8 Hours]**

- 2.1 Introduction.
- 2.2 Three dimensional – Scaling, shearing, rotation, reflection, translation.
- 2.3 Multiple transformations.
- 2.4 Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space.
- 2.5 Reflection through an arbitrary plane.

**Unit 3: Projection [8 Hours]**

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- 3.1 Orthographic projections.
- 3.2 Axonometric projections.
- 3.3 Oblique projections.
- 3.4 Perspective Transformations.

### Unit 4: Plane and Space Curves

[6 Hours]

- 4.1 Introduction.
- 4.2 Curve representation.
- 4.3 Parametric curves.
- 4.4 Parametric representation of a circle.
- 4.5 Bezier Curves – Introduction, definition, properties (statement only), Curve fitting (up to  $n = 3$ ), equation of the curve in matrix form (up to  $n = 3$ ).

#### Practicals:

- |   |                            |            |
|---|----------------------------|------------|
| 1 | Practicals based on Unit 1 | [15 Hours] |
| 2 | Practicals based on Unit 2 | [15 Hours] |
| 3 | Practicals based on Unit 3 | [15 Hours] |
| 4 | Practicals based on Unit 4 | [15 Hours] |

#### Text Book: -

D. F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill, Second Edition. Unit 1: Chapter 2: Sec. 2.1 to 2.20, Unit 2: Chapter 3: Sec. 3.1 to 3.10. Unit 3: Chapter 3: Sec. 3.12 to 3.15, Unit 4: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5, Chapter 5: Sec. 5.1, 5.8.

#### References:

1. Computer Graphics with OpenGL, Donald Hearn, M. Pauline Baker, Warren Carithers, Pearson (4th Edition).
2. Schaum Series, Computer Graphics by Zhigang Xiang and Roy A. Plastock

## Semester – VI

### NMTMJ-361: Real Analysis-II (Major) (2 credits)

#### Course specific outcomes:

- CO1: Learn about some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
- CO2: Learn about beta and gamma functions and their properties.
- CO3: Recognize the difference between pointwise and uniform convergence of a sequence of functions.
- CO4: Illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability.

#### Course Content

#### Unit 1: Riemann Integration [12 Lectures]

- 1.1 Sets of Measure zero
- 1.2 Definition of the Riemann Integral
- 1.3 Existence of the Riemann Integral
- 1.4 Properties of the Riemann Integral
- 1.5 Fundamental Theorems of Calculus
- 1.6 Improper Integrals types, examples, tests for convergence (statement only).

#### Unit 2: Sequences of Functions [9 Lectures]

- 2.1 Pointwise convergence of sequences of functions
- 2.2 Uniform convergence of sequences of functions
- 2.3 Consequences of uniform convergence

#### Unit 3: Series of Functions [9 Lectures]

- 3.1 Convergence and uniform convergence of series of functions
- 3.2 Integration and differentiation of series of functions

#### Text Books: -

Methods of Real Analysis, Second Edition, Richard R. Goldberg, John Wiley and Sons, Inc.

## **T. Y. B. Sc. Mathematics Syllabus for NEP 2.0**

### **References: -**

1. Real Analysis, N. L. Carothers, Cambridge University Press
2. Introduction to Real Analysis, Third edition, Robert, G. Bartle, Donald Sherbet, John Wiley and Sons.
3. A Basic Course in Real Analysis, Ajit Kumar and S. Kumaresan, CRC Press, Second Indian, CRC Press (Chapman and Hall)
4. A course of Mathematical Analysis, Revised edition, Shanti Narayan and Mittal - S. Chand and Co. (2002).
5. Mathematical Analysis, third Editions'. Malik and Savita Arora - New Age International Publications.

**NMTMJ-362: Ring Theory (Major) (2 Credits)**

**Course specific outcomes: -**

This course will enable the student to:

- CO1: Understand the fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms
- CO2: Learn about ideals and various types of ideals viz. Principal, Prime and Maximal Ideals
- CO3: Learn in detail about Polynomial rings
- CO4: Learn in detail Principal Ideal Domain, Unique Factorization Domain, Euclidean Domain and the relationship between these.

**Course Contents**

<b>Unit 1: Rings and Fields</b>	<b>[7 Lectures]</b>
1.1 Ring, Subring, Fields.	
1.2 Divisors of zero, Integral Domain	
1.3 Characteristic of a Ring	
<b>Unit 2: Ideals</b>	<b>[7 Lectures]</b>
2.1 Ideals	
2.2 Various types of Ideals - Principal Ideal, Prime Ideal, Maximal Ideal	
<b>Unit 3: Homomorphisms and Quotient Rings</b>	<b>[9 Lectures]</b>
3.1 Homomorphism, Properties of Homomorphism, Isomorphism	
3.2 Quotient Ring	
3.3 Fundamental Homomorphism Theorem	
3.4 The Field of Quotients of an Integral Domain.	
<b>Unit 4: Rings of Polynomials &amp; Factorization</b>	<b>[7 Lectures]</b>
4.1 Rings of Polynomials	
4.2 The Evaluation Homomorphism	
4.3 The Division Algorithm in $F[x]$	
4.4 Factorization of a Polynomial over a Field	
4.5 Irreducible Polynomials, Eisenstein's Criterion	
<b>Unit 5: Factorization</b>	<b>[9 Lectures]</b>
5.1 Principal Ideal Domain	

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5.2 Unique Factorization Domain, PID implies UFD, Gauss Lemma,  $D[x]$  is a UFD

(Statement only)

5.3 Euclidean Norm – properties and examples, Euclidean Domain, Problems on GCD using Euclidean Algorithm (Statement only), ED implies PID and hence UFD

5.4 Gaussian Integers, Multiplicative Norm.

### **Text Book: -**

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Pearson.

Unit 1: Section 18, 19, 21.

Unit 2: Section 22 and 23.

Unit 3: Section 26 and 27.

Unit 4: Section 45, 46 and 47 (except theorem 47.10).

### **References:**

1. A Course in Abstract Algebra, 5th Edition, by V. K. Khanna & S. K. Bhambri, Vikas Publishing House, 2016.
2. Joseph A. Gallian, Contemporary Abstract Algebra, 7th Edition, Narosa Publishing House.
3. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Edition, John Wiley and Sons, Inc.
4. I.N. Herstein, Abstract Algebra, 3rd Edition, Prentice Hall of India.

## **NMTMJ-353: Complex Analysis (Major) (2 Credits)**

### **Course specific outcomes: -**

This course will enable the students to:

CO1: Explain the algebraic, geometric, and polar representation of complex numbers.

Perform operations on complex numbers and analyze their properties.

CO2: Define and determine analytic (holomorphic) functions. Apply Cauchy-Riemann Equations to test differentiability.

CO3: Compute contour integrals using parameterization and direct integration techniques. Apply Cauchy's Integral Theorem and Cauchy's Integral Formula in evaluating integrals and function properties.

CO4: Determine the power series representation of analytic functions. Identify and analyze the convergence of Taylor and Laurent series.

CO5: Identify singular points (removable, poles, essential singularities) of a complex function. Use the Residue Theorem to evaluate real and complex integrals.

### **Course Content**

#### **Unit 1: Analytic functions [8 Lectures]**

1.1 Functions of a Complex Variables

1.2 Limits, Theorems on limits (Without Proof), Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulas (Without Proof)

1.3 Cauchy- Riemann Equations, Sufficient Conditions for differentiability (Only Statement and Examples)

1.4 Polar coordinates, Analytic functions, Harmonic functions.

#### **Unit 2: Elementary Functions [5 Lectures]**

2.1 The Exponential functions.

2.2 The Logarithmic function, Branches and derivatives of logarithms, some identities involving logarithms.

2.3 Complex exponents, Trigonometric functions.

#### **Unit 3: Integrals [7 Lectures]**

3.1 Derivatives of functions, Definite integrals of functions.

3.2 Contours, Contour integral, Examples.

3.3 Upper bounds for Moduli of contour integrals, Anti-derivatives (Only Examples)

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3.4 Cauchy-Goursat Theorem (without proof), Simply and multiply Connected domains.

Cauchy integral formula, Derivatives of analytic functions. Liouville's Theorem and Fundamental Theorem of Algebra.

### **Unit 4: Series**

**[5 Lectures]**

4.1 Convergence of sequences and series (Theorems without proof)

4.2 Taylor's series (without proof), Laurent series (without proof), examples only.

### **Unit 5: Residues and Poles**

**[5 Lectures]**

5.1 Isolated singular points, Residues

5.2 Cauchy residue theorem (Without Proof), residue at infinity, types of isolated singular points, residues at poles

5.3 Zeros of analytic functions, zeros and poles.

### **Text Book:**

J.W. Brown and R.V. Churchill, Complex Variables and Applications, International Student Edition, 2009. (Eighth Edition).

Chapter 1: §1 to §11

Chapter 2: §12, §15 to §26.

Chapter 3 : §29 to §34.

Chapter 4 : §37 to §44, §46 and §48 to §53.

Chapter 5 : §55 to §60 and §62.

Chapter 6: §68 to §76.

### **Reference Books:**

1. S. Ponnusamy, Complex Analysis, Second Edition (Narosa).
2. S. Lang, Complex Analysis, (Springer Verlag).
3. A.R. Shastri, An Introduction to Complex Analysis, (MacMillan).
4. L.V. Ahlfors, Complex Analysis, 3rd edition, McGraw Hill, 2000.
5. H.A. Priestley, Introduction to Complex Analysis, 2nd edition (Indian), Oxford, 2006.

## NMTMJ-364: Partial Differential Equations (Major) (2 Credits)

### Course specific outcomes: -

This course will enable the students to:

CO1: Understand and describe surfaces and curves in three dimensions and relate them to differential equations involving three variables.

CO2: Solve simultaneous differential equations of first order and first degree using standard analytical methods.

CO3: Apply appropriate techniques to solve equations of the form  $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$

CO4: Formulate and solve Pfaffian differential forms and equations in three variables, including complete integrals.

CO5: Explain the origin and formation of first-order partial differential equations and solve linear first-order PDEs.

CO6: Determine integral surfaces passing through a given curve for first-order partial differential equations.

CO7: Analyse the origin and structure of second-order partial differential equations and solve linear PDEs with constant coefficients.

CO8: Apply suitable methods to solve reducible and irreducible second-order linear PDEs with constant coefficients.

CO9: Classify second-order partial differential equations into elliptic, parabolic, and hyperbolic types and reduce them to canonical forms.

CO10: Solve Laplace's equation using the method of separation of variables for standard boundary conditions.

### Course Content

#### Unit 1: Introduction to Ordinary and Partial Differential Equations [8 Lectures]

1.1 Surfaces and curves in three dimensions

1.2 Simultaneous differential equations of the first order and the first degree in three variable.

1.3 Methods of solution of  $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$

1.4 Pfaffian differential forms and equations.

1.5 Solution of Pfaffian differential equations in three variables

#### Unit 2: Partial Differential Equations

[8 Lectures]

2.1 Introduction to Partial Differential Equations

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2.2 Origin of first order Partial Differential Equations

2.3 Linear equations of first order equations

2.4 Integral surfaces passing through given curve

### **Unit 3: Second Order Partial Differential Equations [8 Lectures]**

3.1 The Origin of Second Order Partial Differential Equations.

3.2 Linear Partial Differential Equations with constant coefficients.

3.3 Methods of solving Linear Partial Differential Equations

3.3.1 Solution of reducible equations

3.3.2 Solution of irreducible equations with constant coefficients

### **Unit 4: Classification of Partial Differential Equations [6 Lectures]**

4.1 Classification of second order partial differential equations, canonical forms

4.2 Solution of Laplace equations by separation variables methods

4.3 Solution of wave equation by separation variables method.

#### **Textbooks: -**

Ian Sneddon, Element of Partial Differential Equations, McGraw-Hill Book Company, McGraw-Hill Book Company.

#### **Reference Books: -**

- 1 T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Publishing, House 2nd Edition, 2003 (Reprint, 2006).
- 2 K. Sankara Rao, Introduction to Partial Differential Equations, Third Edition, PHI.
- 3 J.N. Sharma, Kehar Singh, Partial Differential equations for Engineers and Scientists, second Edition, Narasa Publications.

## **NMTMJ-365: Practical Based on 361 and 362**

### **Practicals Based on Real Analysis-II [30 Lectures]**

Practical 1: Riemann Integrals-I

Practical 2: Riemann Integrals-II

Practical 3: Improper Integrals

Practical 4: Sequence of functions

Practical 5: Series of functions-I

Practical 6: Series of functions-II

### **Practicals Based on Ring Theory [30 Lectures]**

**NMTMJ-366: Practical Based on 363 and 364**

Practicals Based on Complex Analysis [30 Lectures]

Practicals Based on Partial Differential Equations [30 Lectures]

**NMTMJ-3610(A): Computational Geometry (Elective) (2 Credits)**

**Course specific outcomes: -**

This course will enable student to:

CO4: Gain knowledge of the problems that can be solved using computation geometry

CO5: Understand general techniques for solving problems within computational geometry

CO6: Understand the concept of algorithms in computational geometry

**Course Content**

**Unit 1: Two Dimensional Transformations [8 Lectures]**

- 1.17 Introduction.
- 1.18 Representation of points.
- 1.19 Transformations and matrices.
- 1.20 Transformation of – points, straight lines.
- 1.21 Midpoint Transformation.
- 1.22 Transformation of – parallel lines, intersecting lines.
- 1.23 Transformation: rotations, reflections, scaling.
- 1.24 Combined transformations.
- 1.25 Transformation of a unit square.
- 1.26 Solid body transformations.
- 1.27 Translations and homogeneous coordinates.
- 1.28 Rotation about an arbitrary point.
- 1.29 Reflection through an arbitrary line.
- 1.30 Projection – A Geometric Interpretation of Homogeneous Coordinates.
- 1.31 Overall Scaling.
- 1.32 Points at Infinity.

**Unit 2: Three Dimensional Transformations [8 Lectures]**

- 2.6 Introduction.
- 2.7 Three dimensional – Scaling, shearing, rotation, reflection, translation.
- 2.8 Multiple transformations.
- 2.9 Rotation about – an axis parallel to coordinate axes, an arbitrary axis in space.
- 2.10 Reflection through an arbitrary plane.

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### Unit 3: Projection

[8 Lectures]

3.5 Orthographic projections.

3.6 Axonometric projections.

3.7 Oblique projections.

3.8 Perspective Transformations.

### Unit 4: Plane and Space Curves

[6 Lectures]

4.6 Introduction.

4.7 Curve representation.

4.8 Parametric curves.

4.9 Parametric representation of a circle.

4.10 Bezier Curves – Introduction, definition, properties (statement only), Curve fitting (up to  $n = 3$ ), equation of the curve in matrix form (up to  $n = 3$ ).

### Text Book: -

D. F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill, Second Edition. Unit 1: Chapter 2: Sec. 2.1 to 2.20, Unit 2: Chapter 3: Sec. 3.1 to 3.10. Unit 3: Chapter 3: Sec. 3.12 to 3.15, Unit 4: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5, Chapter 5: Sec. 5.1, 5.8.

### References: -

- 1 Computer Graphics with OpenGL, Donald Hearn, M. Pauline Baker, Warren Carithers, Pearson (4th Edition).
- 2 Schaum Series, Computer Graphics by Zhigang Xiang and Roy A. Plastock

**NMTMJ-3611(A): Practical based on 3610(A) (2 credits)**

**Course specific outcomes: -**

This course will enable student to:

CO1: Gain knowledge of the problems that can be solved using computation geometry

CO2: Use techniques for solving problems within computational geometry

CO3: Use algorithms in computational geometry

**Course Content**

1	Practicals based on Unit 1	<b>[15 Hours]</b>
2	Practicals based on Unit 2	<b>[15 Hours]</b>
3	Practicals based on Unit 3	<b>[15 Hours]</b>
4	Practicals based on Unit 4	<b>[15 Hours]</b>

**Text Book: -**

- 1 D. F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill, Second Edition.  
Unit 1: Chapter 2: Sec. 2.1 to 2.20,  
Unit 2: Chapter 3: Sec. 3.1 to 3.10.  
Unit 3: Chapter 3: Sec. 3.12 to 3.15,  
Unit 4: Chapter 4: Sec. 4.1, 4.2, 4.4, 4.5, Chapter 5: Sec. 5.1, 5.8.

**NMTMJ-3610(B): Optimization Techniques (Elective) (2 Credits)**

**Course specific outcomes: -**

This course will enable the student to:

- CO1: To introduce network models and optimization techniques for solving some network related problems.
- CO2: To introduce Games and strategies and its applications.
- CO3: To learn about sequencing problems and its solution process.
- CO4: To introduce the methods to optimize single-variable functions and multi-variable functions.
- CO5: To learn about theory of replacement and its utilities.

**Course Content**

**Unit 1: Network Models** **[10 Lectures]**

- 1.1 Scope and Definition of Network Models
- 1.2 CPM -Critical activity, Critical path, Critical time
- 1.3 PERT - Expected time, Expected variance, Critical activity, Critical path

**Unit 2: Replacement and Maintenance Models** **[10 Lectures]**

- 2.1 Introduction
- 2.2 Types of Failure -Gradual Failure, Sudden Failure
- 2.3 Replacement of Items whose Efficiency Deteriorates with Time, Replacement of Item that completely Fail
- 2.4 Sequencing Problems
  - 2.4.1 Introduction, Notations, Terminology and Assumptions
  - 2.4.2 Processing n jobs through two machines
  - 2.4.3 Processing n jobs through three machines

**Unit 3: Game Theory** **[10 Lectures]**

- 3.1 Introduction
- 3.2 Two-Person Zero-Sum Games

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3.3 Pure Strategies (Minimax and Maximin Principles): Games with Saddle Point

3.4 Rules to Determine Saddle Point

3.5 Mixed Strategies: Games without Saddle Point

3.6 The Rules (Principles) of Dominance

3.7 Solution Methods Games without Saddle Point

### **Textbooks: -**

- 1 Hamy A. Taha, Operations Research, (Eighth Edition, Prentice Hall of India), 2008.

### **References: -**

- 1 J. K. Sharma, Operations Research, (Third Edition, Macmillan India Ltd.), 2008.
- 2 P. K. Gupta and D. S. Haria, Operations Research, (Fifth Edition, S. Chand), 2014.

## **NMTMJ-3611(B): Practical based on NMT-3610(B) (2 credits)**

Practicals Based on Optimization Techniques

**[60 Lectures]**

**NMTVSC- 3621: Graph Theory (2 Credits)**

**Course specific outcomes: -**

This course will enable the student to:

CO1: Understand and apply the fundamental concepts in graph theory

CO2: Study various types of graphs

CO3: Apply graph theory-based tools in solving practical problems

CO4: Develop proof writing skills.

**Course Content**

**Practical 1: An Introduction to Graphs [15 Lectures]**

- 1.1 The definition of a Graph
- 1.2 Graphs and Models, More Definitions
- 1.3 Vertex Degree
- 1.4 Sub graphs, Paths and Cycles,
- 1.5 The Matrix Representation of Graphs, Fusion

**Practical 2: Trees and Connectivity [15 Lectures]**

- 2.1 Definition and Simple Properties,
- 2.2 Bridges, Spanning Trees,
- 2.3 Connector Problems
- 2.4 Shortest Path Problems
- 2.5 Cut Vertices and Connectivity

**Practical 3: Euler Tours and Hamiltonian Cycles [15 Lectures]**

- 3.1 Euler Tours
- 3.2 Chinese Postman Problem
- 3.3 Hamiltonian Graphs
- 3.4 Travelling Salesman Problem.

**Practical 4: Directed Graphs [15 Lectures]**

- 4.1 Definitions
- 4.2 In degree, out degree
- 4.3 Tournaments
- 4.4 Traffic Flow.

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### **Text Book: -**

- 1 A First Look at Graph Theory, John Clark and Derek Allan Holton, Allied Publishers Ltd.(1991), Chapter No. 1, 2, 3 and 7.

### **Reference Books: -**

- 1 Introduction to Graph Theory, R. J. Wilson, Pearson(2003)
- 2 Graph Theory, Harary, Narosa Publishers, New Delhi(1989).
- 3 Basic Graph Theory, K. R. Parthasarathy, Tata McGraw Hill Publisher Co. Ltd.
- 4 Introduction to Graph Theory, Douglas West, Second Edition.

## T. Y. B. Sc. Mathematics Syllabus for NEP 2.0

The Examination pattern for all Undergraduate (UG) courses.

### EVALUATION PATTERN: For Two Credit Courses

- (i) Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
- (ii) Continuous Evaluation shall be of 15 marks and End Semester Examination (EE) shall be of 35 marks
- (iii) To pass a course of 2credits, a student has to earn minimum 20 marks, provided that he/she should earn minimum 6 marks in Continuous Evaluation and minimum 14 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
- (iv) For Internal evaluation (out of 15 marks), There has to be one written test of 10 marks (Mid-Semester Examination). For remaining 5 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc.(on approval of Head of the Department)
- (v) There shall be revaluation of the answer scripts of End-Semester Examination (out of 35 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. **134 A and B**.

### ATKT RULES

- (i) Minimum number of credits required to take admission to Second year of B. Sc. course is 31 (70%) (As same as SPPU).
- (ii) Minimum number of credits required to take admission to Third year of B. Sc. course is 44 (100%) to be completed from First year of B. Sc. and pass in physical education examination in first year of B. Sc. and 22 credits from second year of B. Sc (As same as SPPU).

### AWARD OF GRADES AND GRADE POINTS

The mapping of percentage to letter grade and grade point is given in the following Table 1  
CGPA will be calculated as follows:

**Table 1**

Sr. No.	Grade Letter	Grade Point	Marks
1.	O (Outstanding)	10	$90 \leq \text{Marks} \leq 100$
2.	A+ (Excellent)	9	$80 \leq \text{Marks} \leq 89$
3.	A (Very Good)	8	$70 \leq \text{Marks} \leq 79$
4.	B+ (Good)	7	$55 \leq \text{Marks} \leq 69$
5.	B (Above Average)	6	$50 \leq \text{Marks} \leq 54$
6.	C (Average)	5	$45 \leq \text{Marks} \leq 49$
7.	D (Pass)	4	$40 \leq \text{Marks} \leq 44$
8.	F (Fail)	0	Marks < 40
9.	Ab (Absent)	0	

**PERFORMANCE INDICES:**

The performance of a student in a Semester is indicated by a number called the Semester Grade Point Average (SGPA). Similarly, the performance of a student in the Course is indicated by a number called the Course Grade Point Average (CGPA).

The End-Semester results and final result of the courses will contain SGPA and CGPA, respectively.

- 1) **SGPA**: The SGPA is the weighted average of the grade points obtained by a students in all the courses during the Semester. That is

$$SGPA = \frac{\sum_{i=1}^p C_i G_i}{\sum_{i=1}^p C_i}$$

For example, suppose in a Semester, student has registered for five courses having credits C1, C2, C3, C4 and C5 and suppose his/her grade points are G1, G2, G3, G4 and G5, respectively. The SGPA is calculated as

$$SGPA = \frac{C_1 G_1 + C_2 G_2 + C_3 G_3 + C_4 G_4 + C_5 G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

SGPA is calculated correct up to two decimal places by rounding off.

- 2) **CGPA**: The CGPA is the weighted average of the grade points obtained in all courses (theory and Practical's) by students in all the courses in 6 semesters. It is calculated in the same manner as the SGPA.

**RESULTS:**

Based on the performance of the student in the Semester Examinations, Nowrosjee Wadia College will declare the results and issue the Semester Grade sheets. Also, the College will declare the results and issue the Grade sheets at the end of the course.

The class will be awarded to a student on the basis of CGPA. The award of the class shall be as per Table 2 and corresponding percentage calculation for the CGPA is given in Table No. 3

**Table 2**

Sr. No.	CGPA	Class of the degree awarded
1	9.50 or more than 9.50	OUTSTANDING (O)
2	8.50 or more but less than 9.50	EXCELLENT (A+)
3	7.50 or more but less than 8.50	VERY GOOD (A)
4	6.25 or more but less than 7.50	GOOD (B+)
5	5.25 or more but less than 6.25	ABOVE AVERAGE (B)
6	4.75 or more but less than 5.25	AVERAGE (C)
7	4.00 or more but less than 4.75	PASS (D)

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Percentage of marks corresponding to CGPA is calculated by the formulae which are given in the following Table 3.

**Table 3**

GRADE	Formula for the percentage of marks
O	$20 \times \text{CGPA} - 100$
A+	$10 \times \text{CGPA} - 5$
A	$10 \times \text{CGPA} - 5$
B+	$12 \times \text{CGPA} - 20$
B	$5 \times \text{CGPA} + 23.75$
C	$10 \times \text{CGPA} - 2.50$
D	$6.6 \times \text{CGPA} + 13.6$

The above percentage calculations are illustrated in the following Table 4

Table 4

Some examples of CGPA to Percentage calculations

CGPA obtained	Formula	Percentage (%)	Grade
10	$20 \times 10 - 100 = 100$	100	O
9.75	$20 \times 9.75 - 100 = 95$	95	O
9.5	$20 \times 9.5 - 100 = 90$	90	O
9.0	$10 \times 9 - 5 = 85$	85	A+
8.0	$10 \times 8.0 - 5 = 75$	75	A
7.0	$12 \times 7.0 - 20 = 64$	64	B+
6.67	$12 \times 6.67 - 20 = 60.04$	60.04	B+
6.25	$12 \times 6.25 - 20 = 55$	55	B+
5.25	$5 \times 5.25 + 23.75 = 50$	50	B
4.75	$10 \times 4.75 - 2.50 = 45$	45	C
4.0	$6.6 \times 4.0 + 13.6 = 40$	40	D

While declaring the results, the existing ordinances are applicable. There is also a provision for verification and revaluation. In case of verification, the existing rules will be applicable. The revaluation result will be adopted if there is a change of at least 10% marks and in the grade of the course.

### **PATTERN OF THE QUESTION PAPER: Two Credits**

#### **(1) Internal Examination:**

(Mid-Semester Examination of 10 marks, Duration: 30 Minutes)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Attempt	Definitions/Counter

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		any 5 out of 7	examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	5	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 5 marks)

### (2) End Semester Examination(EE):

Shall be of 35 marks, 2 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Solve any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 1 mark.)
Q. 2.	10	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 3.	10	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	10	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions

### EVALUATION PATTERN: For Four Credit Courses

- (i) Each course shall be evaluated with Continuous Evaluation (CE) and End Semester Examination (EE).
- (ii) Continuous Evaluation shall be of 30 marks and End Semester Examination (EE) shall be of 70 marks
- (iii) To pass a course of 4credits, a student has to earn minimum 40 marks, provided that he/she should earn minimum 12 marks in Continuous Evaluation and minimum 28 marks in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.
- (iv) For Internal evaluation (out of 30 marks), There has to be one written test of 20 marks (Mid-Semester Examination). For remaining 10 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department)

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- (v) There shall be revaluation of the answer scripts of End-Semester Examination (out of 70 marks) of theory papers only, but not of internal assessment papers as per Ordinance No. 134 A and B.

### **PATTERN OF THE QUESTION PAPER: Four Credits**

#### **(1) Internal Examination:**

(Mid-Semester Examination of 10 marks, Duration: 30 Minutes.)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	10	Attempt any 5 out of 7	Definitions/Counter examples/Short answer / objective type of questions/True or False. (Each question carries 2 marks)
Q. 2.	10	Solve any 1 out of 2 questions	Descriptive type questions (Each question carries 10 marks)

#### **(2) End Semester Examination (EE):**

Shall be of 70 marks, 2 hours and 30 Minutes duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of Questions	Remarks
Q. 1.	10	Solve any 5 out of 7	Definitions/ Counter examples/ Short answer / Objective type of questions/ True or False. (Each question carries 2 marks)
Q. 2.	20	Solve any 5 out of 7 OR Solve any 2 out of 3	Descriptive type questions
Q. 3.	20	Solve any 2 out of 3	Descriptive type questions (Each question carries 5 marks)
Q. 4.	20	Solve any 2 out of 3 OR Solve any 1 out of 2	Descriptive type questions