Savitribai Phule Pune University, Pune

(Formerly, University of Pune)

Four Year (Semester 01 to 08)

B.A./B.Sc. (Honours/Honours with Research)

Major in MATHEMATICS

[2024 Pattern]

Syllabus

National Education Policy- 2020

To be Implemented From The Academic Year : 2024- 2025

Prepared by : B.O.S. MATHEMATICS, SPPU

Recommended by: Faculty, Science and Technology

Approved by : Academic Council, SPPU

References:

1. vide G.R. No. NEP-2022/CR No. 09/VISHI-3/f$d›w, dated 20 April,2023.
2. University Circular No. 97, Dated 31 May, 2023.

(For Colleges Affiliated to Savitribai Phule Pune University, Pune.)

Savitribai Phule Pune University

(Formerly University of Pune)

Four Year Graduate Degree Program in Mathematics

(Faculty of Science & Technology)

New Syllabi

for

B. A. / B. Sc. - Mathematics Part-I

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

(As per National Education Policy- 2020)

To be implemented from the Academic Year 2024-2025

Preamble

The board of studies in Mathematics of Savitribai Phule Pune University, made a rigorous attempt to revise the curriculum of degree program B.Sc. to align it with National Education Policy-2020 and UGC quality mandate for Higher Education Institutions-2021. The process of revamping the curriculum started with the series of meetings, workshops, webinars and discussions with sub-committees conducted by the university to orient the teachers about the key features of the National Education Policy, enabling them to revise the curriculum in sync with the policy. Appropriate orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the policy in the revised curriculum focused on creating holistic, thoughtful, creative and well-rounded individuals equipped with the skill sets of 21^{st} century for the development of an enlightened, socially conscious, knowledgeable and skilled citizen of the nation.

With NEP-2020 in background, the revised curriculum will articulate the spirit of the policy by emphasizing upon integrated approach to learning, innovative pedagogies and assessment strategies, multidisciplinary and interdisciplinary education, creative and critical thinking, student-centric participatory learning, imaginative abilities and flexible curricular structures to enable creative combination of disciplines for the study. The credit structure is followed by university as it is as per the guidelines of state government to design the Degree Program. The curriculum is further modified as per the needs specified in NEP. The curriculum is developed to trigger the inquisitiveness, discussion, analytical ability and quest for discovery among learners.

Mathematics is a powerful tool for understanding and communicate globally that organizes our lives and prevents chaos, which helps us to understand the world and provides an effective way of building mental discipline. Along with mathematical skills, it is also expected that students will learn life skills like argumentation, communication and general social values which are necessary to life rich, productive and meaningful life. Additionally, the knowledge of mathematical modelling and computational training which the students acquire during the Program makes them highly sought after. In keeping with the demands of industry and academia, the syllabus is updated regularly, with inputs taken from various stakeholders including students, alumni and parents at different stages of the modification/addition of the syllabus. The new curriculum provides a synoptic overview of possible career paths mapped by a degree in mathematics teaching, research, engineering, computer programming, statistician, competitive examinations and many more.

******

Four Year Degree Program in Mathematics under the Faculty of Science and Technology

B.A./B.Sc. (Honours/ Honours with Research)

Major in Mathematics (2024 Pattern)

ABOUT THE PROGRAM:

This B.Sc. Program is uniquely designed to impart essential knowledge in all major areas of pure or applied mathematics. This Program offers an exciting opportunity for specialization in constructing mathematical models for real-life problems and solve them. The program consists of total 08 semesters which are carefully selected blend of theory and practical. It provides feast of mathematical concepts and advanced knowledge in mathematics which are useful to students for specialist professional employment, research in academia and various industries for broader applications. Learner centric curriculum is designed in adherence to the principles of National Education Policy (NEP 2020) to acquire knowledge and skills with valuable experiences through VSC, SEC, AEC, VEC, IKS, hands-on activities, projects, internships and much more.

OBJECTIVES OF THE PROGRAM:

- To prepare the learners, who will understand and apply the basic as well as advanced principles of mathematics for solving problems from science with an emphasis on applications.
- To produce the learners who are well-grounded in the fundamentals of mathematics with the acquisition of the necessary skills, tools, and techniques required in many applications areas.
- To develop an ability to study the conceptual problem and critically analyze and also promote the use of mathematics in industry and applied sciences.
- To provide exposure and motivate students for research in current trends of mathematics.

SCOPE OF THE PROGRAM:

After successful completion of the B.Sc. Program, the learner has ample opportunities to use their mathematical knowledge in different areas:

- Career opportunities in government organizations like Defense Research and Development Organization (DRDO), Indian Space Research Organization (ISRO), research laboratories like Council of Scientific and Industrial Research or government owned scientific organizations.
- Job positions like Mathematics specialist, Quantitative risk analyst, Treasury management specialist, Public sector banking, Financial institutions, Engineering or Insurance sectors, etc.
- Job opportunities in the teaching profession at science and engineering colleges and universities.
- Scope for Higher Studies and find lucrative opportunities in the field of research.

PROGRAM OUTCOMES(PO's):

After successful completion of this program, students will be able to

1. enhance their logical thinking and apply advanced mathematical concepts to solve complex problems.
2. formulate research questions, design experiments or investigations, collect and analyze data and present their findings in a clear and coherent manner.
3. apply advanced mathematical techniques or tools to analyze and solve challenging problems encountered in mathematics and related fields.
4. formulate mathematical models that represent real-world phenomena, analyze the models using mathematical methods and interpret the results to make informed decisions or predictions.
5. develop proficiency in utilizing computational tools, software and programming languages to aid in mathematical analysis, numerical simulations and data visualization.
6. present complex mathematical concepts, proofs and research findings to both technical and non-technical audiences.
7. develop a strong foundation for professional growth and lifelong learning in Mathematics.
8. acquire lifelong learning skills which will lead important to better opportunities and improve quality of life.
9. gain knowledge with the holistic and multidisciplinary approach across the fields.
10. analyzing the results critically and applying acquired knowledge to solve the problems.
11. be independent innovations and published it though research papers and projects.

PROGRAM SPECIFIC OUTCOMES (PSO's):

The student will

1. have a strong foundation for being research in mathematics.
2. be able to apply mathematical skills for solving problems.
3. at least basic knowledge of programming and computational techniques as required for employment.
4. capable to analyze the results critically and apply acquired knowledge to solve the problems.
5. have at least four different skills and capable to think and communicate in three different languages.
6. be able prepare the models for real life problems.

BASIC INFORMATION:

1. **Title of the Program:** B.A./B. Sc. (Mathematics)
2. **Minimum Duration:**
   i) 3 years for B.Sc. Degree- Major in Mathematics.
   ii) 4 years for B.Sc. Honours with Major in Mathematics.
3. **Maximum Program Duration:** 7 years from the date of admission to the program, also referred as valid registration period.
4. **Medium of Instruction:** English
5. **Attendance:** Minimum 75% attendance for all type of courses.
6. **Teaching-Learning:** 15 weeks per semester
7. **Total Credits:** 132 credits for 3 years under graduate degree and 176 credits for 4 years under graduate (Honours) degree. As per UGC norms one credit means 30 hours for practical/lab sessions and 15 hours for theory.
8. **Semester Credits:** 22 credits in each semester.
9. **Continuous Assessment:** Continuous Assessment(CA) will be conducted for continuous evaluation during teaching-learning. 30% weightage may be considered for one or more of the following.
   i) Home assignment(s)
   ii) Seminar/Presentation (individual / group)
   iii) Laboratory Assignment
   iv) Group discussions / Oral
   v) Research paper review
   vi) Technology demonstration using ICT
10. **End Exam:** End Examination (EE) will be conducted for summative evaluation of the student for 70% weightage.
11. **Passing of course:** Min. 40% in CA and EE each.
12. **Eligibility:**

Admission eligibility for the Program	**Degree Certification Eligibility**
HSC/ (10+2) or equivalent from a recognized board **OR** 10+3 Diploma (any stream) awarded by any state board of technical education	Min 40% marks out of total 132 credits at Semesters 01 to 06 for B.A./B.Sc. Mathematics degree **OR** Min 40% marks out of total 176 credits at semesters I to VIII B.A./B.Sc. Mathematics Honours degree.

13. **Rules for A.T.K.T.:** A student who wishes to take admission to the second year (to register for third or fourth semester) of B. A. /B. Sc. (Mathematics) program has to earn at least 22 credits from the total credits of two semesters of the first year of B. A./B.Sc. (Mathematics).

14. **Multiple Entry and Multiple Exit:**

Level of the Program	Entry Option (with criteria)	Exit Option (with criteria)
Certificate Level	HSC (10+2) OR equivalent from the recognized Board OR 10+3 Diploma (any stream) awarded by any state board of technical education	Award of **UG certificate in Mathematics as Major with 44 credits** and an additional 4 credits core NSQF course/ Internship.
Diploma Level	UG Certificate in Mathematics as Major with 40-44 credits	Award of **UG Diploma in Mathematics as Major with 88 credits** and an additional 4 credits core NSQF course/Intern ship
Degree Level	UG Diploma in Mathematics as with 80-88 credits	Award of **UG Degree in Mathematics as Major with 132 credits**

15. **Abbreviation:**

VSC : Vocational Skill Course
IKS : Indian Knowledge System
FP : Field Project
OJT : On Job Training
CEP : Community Engagement and Service
GE/OE : Generic Elective / Open Elective
SEC : Skill Enhancement Course
AEC : Ability Enhancement Course
VEC : Value Education Course
CC : Co-curricular Courses
RP : Research Project
RM : Research Methodology
T : Theory
P : Practical

16. **Note:**

i) VSC, IKS, FP/OJT/CEP should be related to the Major subject.
ii) The Minor subject may be from the different disciplines of the same faculty of Major (Core) or they can be from different faculty altogether.
iii) OE is to be chosen compulsorily from faculty other than that of the Major.
iv) SEC Prepared by BOS or to be selected from the basket approved by university.
v) Wherever require the BOS can choose theory or practical course as per the need and within the given structure.

17. **EXAMINATION RULES:**

(a) A student cannot appear for semester end examination unless he/she has maintained 75% attendance during the teaching period of that course. If a student fails to maintain 75% attendance at the time of filling of examination forms, an undertaking from the student should be taken stating that he/she will be allowed to appear for examination subject to fulfilment of required attendance criteria during the remaining period of teaching of the course.

(b) Each credit will be evaluated for 25 marks Including End Examination (EE) and Continuous Assessment (CA).

(c) Each course of 04 Credits will have semester End Examination (EE) of 70 Marks and Continues Assessment (CA) of 30 Marks while each course of 02 Credit will have semester-end examination of 35 Marks and Continues Assessment of 15 Marks.

(d) To pass a course, the student has to obtain 40% marks for Continuous assessment (CA) and Semester-End Examination (EE) each of these separately.

(e) If any student is not able to appear for internal assessment examination, he/she may be allowed to appear for examination by the permission of higher authorities based on the verification of reason.

(f) Students who fail to score passing marks in semester-end exam/Continues Assessment may appear for the semester-end exam/ Continuous Assessment in the subsequent period but within allotted period for Program. The allotted period for two, three and four year degree programs is four, five and seven years respectively.

(g) A student cannot register for the subsequent year unless he/she achieves 50% credits of the total credits expected to be ordinarily completed for that particular year. The student can seek admission to third year only after achieving 100% Credits of the first year as well the student seeking admission to fourth year should achieve 100% Credits of second year.

(h) There shall be revaluation of the answer scripts of semester-end examination but not of internal assessment and Practical Examination.

(i) Even though the marks will be given for all examinations, they will be converted into grades. The semester end and final mark sheets and transcripts will have only grades and grade points average.

(j) Continuous Assessment of each Course will have weightage of 30% of marks and a teacher must select at least three components for the examination from the following

  i) Written Test / Mid Term Test/ An Open Book Test
  ii) Seminar/ Group discussion.
  iii) Journal/Lecture/Library notes.
  iv) PPT or poster Presentation.
  v) Short Quizzes.
  vi) Assignments
  vii) Mini Research Project
  viii) Field visit/ Industrial visit

(k) Evaluation of OJT/FP/RP/RM will be done during practical Examination through external examiners by dissertation, Presentation, Oral, Field work project report, etc.

PROGRAM STRUCTURE

Level	Sem	Major				Minor		OE	Cr.	VSC, SEC (VSEC)		AEC, VEC, IKS		OJT, FP, CEP, CC, RP		Cr./ Sem
		Mandatory		Electives												
4.5	I	**MTS-101 MJ:** Algebra**(T)**	2	-		-	-	**OE 105 MTS:** (Choose strictly from other Faculty)	**2**	**MTS-121: VSC** Foundation Mathematics **(T)**	**2**	**MTS-104 IKS:** Ancient Indian Mathematics **(T)**	**2**	**CC 110:** PE/NSS /NCC	**2**	**22**
		MTS-102 MJ: Calculus-I**(T)**	2													
		MTS-103 MJP: Practical Based on MTS101 & MTS102	2					**OE 106 MTS:** (Choose strictly from other Faculty)	**2**	**SEC- 107: MTS** Python-I **(P)**	**2**	**AEC108 ENG:** English Communication**(T)**	**2**			
												VEC109 ENV: Environmental Studies **(T)**	**2**			
	II	**MTS-151 MJ:** Matrix Algebra**(T)**	2	-		**MTS-191 MN:** Minor **(T)** (Choose from other discipline or other faculty)	**2**	**OE 155 MTS:** (Choose strictly from other Faculty)	**2**	**MTS- 171: VSC** R-Programming **(P)**	**2**	**AEC158 ENG:** English Communication **(T)**	**2**	**CC 160**: PE/NSS /NCC	**2**	**22**
		MTS-152 MJ: Calculus-II **(T)**	2													
		MTS-153 MJP: Practical Based on MTS-151 & MTS-152 **(P)**	2					**OE 156 MTS:** (Choose strictly from other Faculty)	**2**	**SEC- 157: MTS** Python-II **(P)**	**2**	**VEC 159 ENV:** Environmental Science **(T)**	**2**			
Cum. Cr.		**12**		**00**		**02**		**08**		**08**		**10**		**04**		**44**
Exit option: Award of UG Certificate in MATHEMATICS as Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor																
5.0	III	**MTS-201 MJ:** Calculus of Several Variables **(T)**	**2**	-		**MTS-241 MN:** Minor **(T)** (As per first year)	2	**OE -205 MTS:** (Choose strictly from other Faculty)	**2**	**MTS-221 VSC:** Mathematical Statistics **(P)**	**2**	**AEC 208**: Modern Indian Language ENG/MAR/HIN**(T)**	**2**	**MTS-231: FP**	**2**	**22**
		MTS-202 MJ: Laplace Transforms **(T)**	**2**													
		MTS-203 MJ: Graph Theory -I**(T)**	**2**			**MTS-242 MNP:** Minor (As per first year)	2							**CC 210:** PE/NSS/NCC	**2**	
		MTS-204 MJP: : Practical Based on MTS201, MTS202 & MTS203**(P)**	**2**													
	IV	**MTS-251 MJ:** Linear Algebra **(T)**	**2**	-		**MTS-291 MN:** Minor **(T)** (As per first year)	**2**	**OE-255 MTS:** (Choose strictly from other Faculty)	**2**	**SEC-256 MTS:** Latex **(T/P)**	**2**	**AEC 258**: Modern Indian Language- ENG/MAR/HIN**(T)**	**2**	**MTS-281: CEP**	**2**	**22**
		MTS-252 MJ: Vector Calculus **(T)**	**2**													
		MTS-253 MJ: Numerical Methods **(T)**	**2**			**MTS-292 MNP:** Minor (As per first year)	2							**CC260:** PE/NSS/NCC	**2**	
		MTS-254 MJP : Practical Based on MTS251,MTS252 & MTS253**(P)**	**2**													
Cum. Cr.		**28**		**00**		**10**		**12**		**12**		**14**		**8+2+2**		**88**
Exit option: Award of UG Diploma in MATHEMATICS as Major with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor																

Level	Sem	Major				Minor		OE		VSC, SEC (VSEC)		AEC, VEC,IKS		OJT, FP, CEP, CC, RP		Cr. / Sem.
		Mandatory		Electives												
5.5	V	**MTS-301 MJ:** Abstract Algebra	2	**MTS-310 MJ:** A) Integral Transform **(T)** OR B) Operations Research-I **(T)**	2	**MTS-341 MN:** Minor **(T)**	2	-	-	**MTS:321 VSC Practical** Data Science	2	-	-	**MTS-331 FP**	2	22
		MTS-302 MJ: Set Theory and Logic	2			**MTS-342 MNP:** Minor (P) (As per first year)	2									
		MTS-303 MJ: Real Analysis	2													
		MTS-304 MJP: Practical Based on MTS-302	2													
		MTS-305 MJP: Practical Based on MTS-303	2	**MTS-311 MJP**: Practical based on MTS-306 (A / B)	2											
	VI	**MTS-351 MJ:** Metric Spaces	2	**MTS-360 MJ:** A) Numerical Analysis **(T)** OR B) Analytical Geometry**(T)**	2	**MTS-391 MN:** Minor**(T)**	2	-	-	-		-	-	**MTS-381 OJT**	4	22
		MTS-352 MJ: Differential Equations	2			**MTS 392 MNP:** Minor (P) (As per first year)	2									
		MTS-353 MJ: Complex Analysis	2													
		MTS-354 MJP: Practical Based on MTS-352	2													
		MTS-355 MJP: Practical Based on MTS-353	2	**MTS-361 MJP:** Practical based on MTS-356 (A / B)	2											
Cum. Cr.		**48**		**08**		**18**		**12**		**14**		**14**		**18**		**132**
Exit option: Award of UG Degree in MATHEMTSCS as Major with 132 credits OR Continue with Major and Minor																

Level	Sem	Major				Minor		OE		VSC, SEC (VSEC)		AEC, VEC, IKS		OJT, FP, CEP,CC, RP		Cum. Cr./Sem
		Mandatory		Electives												
6.0	VII	**MTS -401 MJ:** Linear Algebra**(T)**	2	**MTS-410 MJ:** A)Advanced Numerical Analysis OR B) Number Theory OR C) Combinatorics OR D) Lattice Theory	2	**MTS -441 RM:** Research Methodology **(I)**	4	-		-		-		**MTS 431 RP** Research Project	4	22
		MTS-402 MJP: Practical Based on MTS-401 **(P)**	2													
		MTS -403 MJ: Group Theory	2													
		MTS -404 MJ: Ordinary differentialEquations	2													
		MTS -405 MJP: Programming withPython(P)	2	**MTS-411 MJP:** Practical based on (A/B/C/D)	2											
	VIII	**MTS- 451 MJ:** Topology **(T)**	2	**MTS-460 MJ:** A) Graph Theory-II OR B) Dynamical Systems OR C) Coding Theory OR D) Operations Research-II	2	-								**MTS-481 RP** Research Project	8	22
		MTS- 452 MJP: Practical Based on MTS-451 **(P)**	2													
		MTS- 453 MJ: Ring Theory**(T)**	2													
		MTS- 454 MJ: Advanced Calculus**(T)**	2													
		MTS- 455 MJP: Data Science(P)	2	**MTS-461 MJP:** Practical based on (A/B/C/D)	2											
Cum. Cr.		**76**		**16**		**22**		**12**		**14**		**14**		**22**		**176**
Four Year UG Honours with Research Degree in MATHEMATICS with 176 credits																

Syllabus for F.Y.B.Sc. as per NEP-2020
Subject: Mathematics

Semester - I

MTS 101 MJ-Algebra

Course type: Major **No. of Credits: 02**

Course Objectives: This course aims

1. To provide a first approach to Algebra, which is the basic pillars of mathematics.
2. To cover the basic knowledge of integers and complex numbers.
3. To cover the basic knowledge of polynomials.
4. To study the theory of integers and complex numbers.
5. To get mathematical maturity among the students
6. To develop mathematical thinking and skill.

Course Outcomes: The student will able

1. To know the concept of divisibility.
2. To find Greatest Common Divisor of integers using the Euclidean algorithm.
3. To apply Fermat's theorem.
4. To understand the concept of Euler's phi function.
5. To apply De-Moivre's theorem to find roots of complex numbers.
6. To understand the method of finding roots of polynomials and relationship between roots and coefficients of a Polynomial.

Course Content

Unit 1: Integers **(14 Hours)**

1.1 Well ordering principle, principle of mathematical induction (First Principle).

1.2 Divisibility in Z: Definition and elementary properties, division algorithm, definitions of greatest common divisor (G.C.D.) and least common multiple (L.C.M) of integers, Euclidean Algorithm, basic properties of G.C.D, relatively prime integers.

1.3 Definition prime numbers, The Fundamental theorem of Arithmetic, Euclid's Lemma. The theory of congruence, basic properties of congruence, Fermat's Theorem. Euler's phi Function, Euler's Theorem.

Unit 2: Complex Numbers **(10 Hours)**

2.1 Sums and products, basic algebraic properties, moduli, complex conjugates, polar form, geometrical representation of complex numbers, exponential form, arguments of products and quotients.

2.2 De-Moivre's theorem, roots of complex numbers: The n^{th} roots of unity.

2.3 Euler's Formula, Trigonometric and Hyperbolic functions.

Unit 3: Polynomials **(06 Hours)**

3.1 Definition of a polynomial, degree of a polynomial, Algebra of polynomials, division algorithm (statement and examples). Greatest common divisor (G.C.D) of two polynomials (statement and examples).

3.2 Synthetic division, Remainder theorem, Factor Theorem.

3.3 Relation between the roots and the coefficients of a polynomial.

Reference Books:

1. Elementary Number Theory, David M. Burton, Tata McGraw Hill, Seventh Edition.
   Unit I: Reference book 1: Chapter 1: Sec. 1.1, Chapter 2: Sec. 2.2 to 2.4, Chapter 3: Sec. 3.1, Chapter 4:Sec. 4.2, Chapter 4: Sec. 5.2

2. Complex Variables and Applications, James Ward Brown and Ruel V. Churchill, McGraw Hill, Seventh Edition.
   Unit II: Reference book 2: Chapter 1: Sec. 1 to 11.

3. Theory of Equations, J. V. Uspensky, McGraw Hill Book Company.
   Unit III: Reference book 3: Chapter 2, Chapter 3: Sec. 5

4. Textbook of Algebra, S. K. Shah and S. C. Garg, Vikas Publishing House Pvt. Ltd. Edition 2017.

******

MTS-102 MJ: Calculus -I

Course type: Major **No. of Credits: 02**

Course Objectives: This course aims

1. To establish the fundamental theorem and applications of single variable functions.
2. To understand real numbers and properties of real numbers.
3. To understand the concept of limiting process.
4. To understand Continuity in terms of limits.
5. To understand the relationship between sequences and continuity.
6. To understand the concept of convergence and divergence of a sequence

Course Outcomes: The student will able

1. To classify real numbers and recognize different properties that exits with real numbers.
2. To understand the concept of supremum and infimum and their applications.
3. To understand definition of continuity to pure and applied problems.

4. To draw the graphs of algebraic and transcendental functions considering limits and continuity.

5. To apply these concepts for advanced study in Mathematics (Real Analysis, Complex Analysis, Topology)

6. To apply limit and continuity concept in physical, chemical, and biological sciences.

Course Content

Unit 1: Sequences of Real Numbers **(12 Hours)**

1.1 Algebraic and order properties of real numbers, absolute value, completeness property, Archimedean property , density of rational numbers

1.2 Sequences of real numbers and their limits

1.3 Limit theorems

1.4 Monotone and bounded sequences

1.5 Subsequences

Unit 2: Limits **(10 Hours)**

2.1 Limit of a real-valued function

2.2 Limit theorems

2.3 Right hand limit, Left hand limit

2.4 Sequential criteria for limit

Unit 3: Continuity **(08 Hours)**

3.1 Continuous functions

3.2 Combinations of continuous functions

3.3 Boundedness theorem(statement), Maximum-Minimum theorem for continuous functions (statements),Location of roots theorem(statement), Intermediate value theorem

Reference Books:

1. Robert Bartle, Donald Sherbert, Introduction to Real Analysis (Third Edition), John Wiley and Sons Inc.
   Chapter 2: Section 2.1 to 2.4 (except 2.4.7)
   Chapter 3: 3.1(except 3.1.8, 3.1.9, 3.1.10, 3.1.11 and related examples), 3.2, 3.2.10(statement), 3.2.11(statement), 3.3(except 3.3.5, 3.3.6 and examples involving sum of n terms), 3.4(except 3.4.7, 3.4.8, 3.4.9)
   Chapter 4: 4.1 (except 4.1.6, 4.1.10 (c)), 4.2, 4.3(4.3.1, 4.3.2,4.3.3,4.3.4 and related examples only) Chapter 5: 5.1 (except 5.1.6(h),5.1.7,5.1.8), 5.2 (except 5.2.5), 5.3 , 5.3.2(statement), 5.3.4(statement), 5.3.5(statement), 5.3.8(statement)

2. Michael Spivak, Calculus, Cambridge University Press.

3. Thomas' Calculus (14th edition), Pearson Education.

4. Howard Anton, I. Bivens and Stephan Davis (2016). Calculus (10th edition). Wiley India.

5. Gorakh Prasad , Differential Calculus (19th edition). (2016), Pothishala Pvt. Ltd.

6. T.M. Apostol, Calculus Vol. I , John Wiley, New York.

******

MTS-121 VSC: Foundation of Mathematics

Course type: VSC **No. of Credits: 02**

Course Objectives: This course aims

1. To introduce students towards basic concepts of set theory, logic, and proof.
2. To develop students for problem-solving skills and their ability to think critically about mathematical arguments.
3. To prepare students for advanced mathematics courses.
4. To develop students' ability to communicate mathematical ideas clearly and concisely.
5. To introduce students for the use of technology in mathematics.
6. To prepare students to appreciate the beauty and power of mathematics.

Course Outcomes: The student will able

1. To describe sets and perform basic set operations.
2. To construct and evaluate logical arguments.
3. To use mathematical induction to prove theorems.
4. To prove or disprove statements using counter examples and proof by contradiction.
5. To define and identify equivalence relations and classify functions
6. To compare the cardinalities of different sets.

Course Content

Unit 1: Sets **(06 Hours)**

1.1 Describing a Set

1.2 Subsets

1.3 Set Operations

1.4 Indexed Collections of Sets

1.5 Partitions of Sets

1.6 Cartesian Products of Sets

1.7 Numerically Equivalent Sets

1.8 Denumerable Sets

1.9 Uncountable Sets

Unit 2: Relations and Function **(08 Hours)**

2.1 Relations

2.2 Properties of Relations

2.3 Equivalence Relations

2.4 Properties of Equivalence Classes

2.5 The Definition of Function

2.6 The Set of All Functions from A to B

2.7 One-to-One and Onto Functions

2.8 Bijective Functions

2.9 Composition of Functions

2.10 Inverse Functions

Unit 3: Number System **(08 Hours)**

3.1 Natural Numbers

3.2 Properties of Natural Numbers

3.3 Integers

3.4 Rational and Irrational Numbers

3.5 Real Numbers

3.6 Properties of real numbers

Unit 4: Geometry **(08 Hours)**

Introduction to Equation and Geometrical Structure of Line, Plane, Sphere and Cone.

Reference Books:

1. Mathematical Proofs A Transition to Advanced Mathematics, Gary Chartrand, Albert D. Polimeni and Ping Zhang, 3^{rd} Edition, Pearson.
2. The Foundations of Mathematics, Ian Stewart and David Tall, 2^{nd} Edition, Oxford.
3. Proof Patterns, Mark Joshi, Springer.
4. Analytical Solid Geometry : Shantinarayan, S. Chand and Company Ltd., New Delhi.

******

MTS-104 IKS: Ancient Indian Mathematics

Course type: IKS **No. of Credits: 02**

Course Objectives: This course aims

1. To learn the general concept of Indian Knowledge System.
2. To introduce the contribution of Indian Mathematicians.
3. To understand some methods derived by Ancient Indian Mathematicians in the period 500 BCE to 500 CE.
4. To understand some methods derived by Ancient Indian Mathematicians in the period 500 CE to 1000 CE.
5. To understand some methods derived by Ancient Indian Mathematicians in the period 1000 CE to 1600 CE.
6. To help students appreciate the ingenuity of Ancient Indian Mathematicians.

Course Outcomes: The student will able

1. To understand the general concept of Indian Knowledge System.
2. To understand the overall contribution of Ancient Indian Mathematician.
3. To solve problems based on methods derived by Ancient Indian Mathematicians.
4. To compare some old methods with the modern methods.
5. To understand the techniques derived by Ancient Indian Mathematicians.
6. To appreciate the ingenuity of Ancient Indian Mathematicians.

Course Content

Unit 1: Prehistory period **(10 Hours)**

1.1 Indian Mathematics- An Overview

1.2 Mathematics and astronomy in Vedic literature, Large numbers, Units of measurements (500BCE to 500 CE).

1.3 Sulbasutras: Bodhayana-Pythagoras theorem, methods for circling a square and squaring a circle, approximate value of square root of 2.

1.4 Axiomatic approach in Panini's Astadhyayi, Binary number system in Pingala's work.

1.5 Mathematical contents in Bakhshali Manuscript- square root method.

Unit 2: 500 CE to 1000 CE **(10 Hours)**

2.1 Aryabhatiya of Aryabhata: discoveries about earth, sine and cosines, sine table by Aryabhata, Yuga system for large time measurements, approximate value of pi, Kuttak method to linear Diophantine equations, Arithmetic Progression.

2.2 Bramhasputsidhant of Bramhagupta: Use of zero, negative numbers.

2.3 Solutions of quadratic equations, area of cyclic quadrilateral, Bramhgupta's theorem, Bramhgupta's lemma on composition, short-cut methods for solutions of Pell's equation.

2.4 Decimal place value system: its history, establishment of decimal place value system, its propagation to Arab countries and then to Europe.

2.5 Bhaskara I and Varahmihir: Sine formula by Bhaskara I, formula for the area of a triangle using three sidessome interesting problems from Bhasya.

2.6 Introduction to Varahmihir's work-Panca Siddhantika-Surya Siddhant.

2.7 Mahavira's Ganitsarsangraha: Eulogy to mathematics in a shloka, Garland products, Cube of a number, Rupkamsa Rasi, Permutations, combinations, formula for circumference of ellipse, areas bounded by circles, problems on quadratic equations.

2.8 Jain Mathematics and Buddhist Mathematics

Unit 3: 1000 CE to 1600 CE **(10 Hours)**

3.1 Bhaskracharya's work: some problems from 'Lilavati' and 'Bijganita' books, Chakrawal Method, of Bhaskracharya.

3.2 Ganesa Daivajna-Introduction to the book "Graha Laghvam"

3.3 Work of Kerala School of Mathematics- Series of sine, cosine, tan inverse x, Madhava-Gregory series, Madhava-Leibniz series of $\pi/4$, better values of π, concepts of derivative and integration in Yuktibhasha and Tantrasangrah.

3.4 Modern Mathematics in India-Work of Srinivas Ramanujan-Nested square-roots, partitions of natural numbers, some approximations to pi, method of squaring the circle.

Reference Books:

1. History of Hindu Mathematics (Volumes 1 and 2), B. Datta and A,N. Singh, Bharatiya Kala Prakashan.
2. The Science of the Sulba, University of Calcutta, B. Datta, Cosmo Publication
3. Geometry in Ancient and Medieval India, T.A. Saraswati Amma, Motilal Banarasidass.
4. The History of Ancient Indian Mathematics, C.N. Srinivasiengar, World Press.
5. Studies in the History of Indian Mathematics, C.S. Seshadri (ed),Hindustan Book Agency.
6. NPTEL Lectures by K. Ramasubramanian, M.D. Srinivas and M.S. Sriram, https://nptel.ac.in/cou
7. Series of articles on Mathematics in India in Bhavana from January 2022 and his articles in January and October 2017 issues of Bhavana by A.K. Dutta.
8. Indian Mathematics and Astronomy-Some Landmarks, Dr. Balachandra Rao, 6^{th} Edition, Bhavan's Gandhi Centre for Science and Human Values, Bangalore, 2017.
9. A Modern Indian Method, by B. Suri, 2010.

******

SEC-107 MTS: Python-I

Course type: SEC **No. of Credits: 02**

Course Objectives: This course aims

1. To know about python IDE.
2. To write, test, and debug simple Python programs.
3. To implement Python programs with conditionals and loops statements.
4. To understand the syntax of strings in Python.
5. To understand the concept of function.
6. To understand the concept of list, tuples and its operation.

Course Outcomes: The student will able

1. To write python programs and develop a small application.
2. To develop logic for problem solving.
3. To be familiar about the basic constructs of programming such as data, operations, conditions, loops, functions etc.
4. To be familiar with string and its operation.
5. To develop basic concepts of function and terminology.
6. To determine the methods to create and develop Python programs by utilizing the data structures like lists and tuples.

Course Content

Unit 1: : Python Basics and IDE **(04 Hours)**

1.1 Introduction of Python.

1.2 Installing Python

1.3 Running Simple Program.

1.4 Removing Keys.

1.5 Traversing a Dictionary

- Practical 1 based on unit 1.

Unit 2: Basics of Python **(08 Hours)**

2.1 Data type of Python.

2.2 Variable declaration rule.

2.3 Python Identifier and reserved words.

2.4 Input Output Function.

2.5 Operator of Python.

2.6 Advanced Python operator(Membership and identity).

2.7 Comments in Python.

2.8 Line and Indentation.

- Practical 2, Practical 3 based on unit 2.

Unit 3: Conditional structure **(08 Hours)**

3.1 if Statements

3.2 if -else and statement

3.3 Nested if

3.4 if-elif-else ladder

- Practical 4 and Practical 5 based on unit 3.

Unit 4: Iteration statement **(12 Hours)**

4.1 Loop Control Structure.

4.1.1 While loop

4.1.2 For loop

4.2 Nested loop

4.3 Break Statement

4.4 Continue Statement

4.5 Pass Statement

- Practical 6, Practical 7 and Practical 8 based on unit 4.

Unit 5: String and Function **(12 Hours)**

5.1 String Basics.

5.2 Accessing and updating String.

5.3 Built-in String Methods.

5.4 Function in Python.

5.5 Declaration and Calling function.

5.6 Function Argument

5.7 Anonymous Functions

- Practical 9, Practical 10 and Practical 11 based on unit 5.

Unit 6: List and Tuple **(16 Hours)**

6.1 Python Lists.

6.2 Accessing and updating List.

6.3 Basic List Operation.

6.4 Built-in List Methods.

6.5 Python Tuple.

6.6 Accessing and updating tuple.

6.7 Basic tuple operation.

6.8 Built-in tuple Method.

- Practical 12 to Practical 15 based on unit 6.

Reference Books:

1. Fundamentals of Python first programs, 2nd Edition, Kenneth A. Lambert.
2. Beginning Python from Novice to Professional, Third Edition, Magnus Lie Hetland.
3. Python for Science and Engineering, Hans-Petter Halvorsen.
4. Python Programming: An Introduction to Computer Science, Third Edition, John Zelle.
5. Introduction to Scientific Computing in Python, Continuum Analytics and Robert Johansson.

******

Semester - II

MTS-151 MJ: Matrix Algebra

Course type: Major **No. of Credits: 02**

Course Objectives:

1. To study matrix and algebraic properties matrices.
2. To study methods of finding inverse of matrix.
3. To study the solution of system of linear equations.
4. To evaluate determinants by row reduction.
5. To learn properties of determinants.
6. To study applications of matrices and determinant.

Course Outcomes: The student will be able to

1. Understand the various types of matrices and its properties.
2. Convert matrix to echelon form using elementary row operations.
3. Learn method to solve the system of linear equations.
4. Understand the concept of determinant and evaluating determinant by different methods.
5. Solve problems using properties of determinant.
6. Apply the concept of matrices and determinant to the problems in chemistry, electronics, cryptography, etc.

Course Content

Unit 1 : Matrix and Determinant **(12 Hours)**

1.1 Matrix, matrix notation and size of matrix.

1.2 Standard types of matrices.

1.3 Addition, Subtraction, Multiplication and algebraic properties of matrices.

1.4 Transpose, trace of matrix and its properties.

1.5 Determinant

1.6 Evaluating determinants by row reduction, Properties of determinants.

1.7 Minor, cofactor matrix and adjoint of matrix.

1.8 Inverse of a matrix and its properties.

1.9 Elementary matrices, Row echelon and reduced row echelon form of matrix, rank of matrix and a method for finding inverse.

Unit 2: System of Linear Equations **(12 Hours)**

2.1 Introduction to systems of linear equations

2.2 Linear systems in two and three unknowns

2.3 Matrix form of a linear system.

2.4 Cramer's rule

2.5 Augmented matrices corresponding to system of linear equations.

2.6 Gaussian elimination and Gauss-Jordan elimination.

2.7 More on linear systems and invertible matrices

2.8 Diagonal, Triangular, and Symmetric matrices

Unit 3: Applications of Matrix Algebra **(06 Hours)**

3.1 Applications to Network analysis

3.2 Applications to electrical circuits

3.3 Applications towards balancing chemical equations

3.4 Applications in Cryptography

Reference Books:

1. Elementary Linear Algebra by Howard Anton, Chris Rorres, 11th edition. Unit 1 and Unit 2: Section.1 to 1.7, Section 2.1 to 2.3 Unit 3 (3.1, 3.2, and 3.3): Section 1.9.1 to 1.9.3.
2. Applied Finite Mathematics by R. Sekhon and R. Bloom, Libre Texts. Unit 3 (3.4): Section 2.5.
3. Matrix and Linear Algebra by K.B.Datta, Prentice Hall India Pvt., Limited, 2004.
4. Fundamentals of Matrix Algebra,(3rd eddition) by G.Hartman.
5. Linear Algebra and its Applications, David Lay, Third Edition, Pearson Publications.
6. Linear Algebra, Kenneth Hoffman, Ray Kunze, MIT Press.

******

MTS-152 MJ: Calculus - II

Course type: Major **No. of Credits: 02**

Course Objectives: In this course student will learn:

1. How to find derivative of function using limit.
2. Geometrical and physical significance of derivative.
3. The use of nth derivatives, to find nth derivatives of product function.
4. The Series expansions of functions at a point.
5. To decide the nature of function using derivative.
6. To find extreme values of a function.

Course Outcomes: The student will able to

1. Understand differentiation and fundamental theorem in differentiation.
2. Apply Mean value theorems and it's applications
3. Find the nth derivatives of the function, evaluate nth derivative of product function.
4. Apply L'Hospital rules to find the limits in indeterminate forms.
5. Find series expansions of some standard functions.
6. Decide nature of functions and find its extreme values.

Course Content

Unit 1: Differentiation **(08 Hours)**

1.1 The derivative of a real valued function at a point

1.2 Geometric and Physical significance of derivative

1.3 Differentiability implies continuity

1.4 Algebra of differentiable functions

1.5 Derivatives of some standard functions using the definition

1.6 Caratheodory's Theorem (without Proof)

1.7 The chain rule

1.8 Derivative of Inverse function (without proof)

Unit 2: Successive Differentiation **(07 Hours)**

2.1 Higher order derivatives of function

2.2 Formulae for nth derivative of $(ax+b)^n$, e^{ax}, $sin(ax+b)$, $cos(ax+b)$, $\frac{1}{(ax+b)}$, $log(ax+b)$, $e^{ax}sin(bx+c)$, $e^{ax}cos(bx+c)$.

2.3 Leibnitz's Theorem

2.4 Indeterminate forms: L'Hopitals Rules (statement and examples)

Unit 3: Mean Value Theorem (08 Hours)

3.1 Interior-extremum Theorem

3.2 Rolle's Theorem

3.3 Lagrange's and Cauchy's Mean Value Theorems

3.4 Applications of MVT's

3.5 Taylor's and Maclaurin's Theorems with Lagrange's form of remainder. (Statements only), Examples.

Unit 4: Maxima and Minima (07 Hours)

4.1 Concave up and concave down functions

4.2 Point of Inflection

4.3 Intervals of Increasing and Decreasing of a function

4.4 Local maximum and minimum values of a function

4.5 First derivative test for extrema

4.6 Second derivative test for extrema (Statement only)

Reference Books:

1. Introduction to Real Analysis (Third Edition), Robert Bartle, Donald Sherbert, Wiley Student Edition.
2. Elements of Real Analysis, Shanti Narayan, M.D. Raisinghaniya, (Revised Ed.-2012), S.Chand & Company Ltd.
3. Calculus Volume-I, T.M. Apostol, John Wiley, New Delhi.
4. Thomas' Calculus (14 th Edition) Pearson Education.

******

MTS-171 VSC: R Programming

Course type: VSC **No. of Credits: 02(P)**

Course Objectives: This course, students will learn

1. To construct data structures in R.
2. The fundamentals of mathematical computation.
3. To perform matrix mathematical operations.
4. Learn simple data visualization using basic techniques from R programming.

5. How to conduct differentiation, integration.
6. How to handle datasets in R.

Course Outcomes: The students will be able to:

1. Demonstrate how to install R software.
2. Explain the use of data structures and conduct arithmetic operations.
3. Using R, solve complicated differentiation and integration problems.
4. Perform different operations on matrices and test their characteristics.
5. Visualize the data using a diagrammatic form.
6. Import datasets in R and export outputs from R

Course Content

Unit 1: Introduction to R **(20 Hours)**

1.1 **Getting started with R Programming**

R is a free, Open Source Programming Language, so students can download from R Programming project Website and install on their own machine (Linux, Windows or MacOS). They do have RStudio, which is an integrated development environment (IDE) that provides a user-friendly interface. The section covers the following topics.
- Installation of R
- Use of R console
- R script/ editor file, R Prompt, Menu Ribbon, Saving R editor/script file
- Clearing R console,
- Comments (single line, multiple line)
- Packages,
- Taking help in R
- Closing R session.

1.2 R Operators

Assignment Operators: $=, <-, ->, <<-, ->>, assign()$

Arithmetic Operators: addition (+), subtraction(−), multiplication(*), division(/), exponent (∧ or **), remainder operator (% %), Integer division (% / %)

Comparison Operators: equal to (==), less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), not equal to (! =)

Logical Operators: element wise logical AND (&), logical AND (& &), element wise logical OR (|), logical OR (||), logical NOT (!), xor(), isTRUE(), isFALSE().

1.3 **Data Structures and R Objects:**
- Constants, Variables
- Vectors
- Matrices
- Data Frame
- Factors
- Lists
- Arrays

Vectors: creating vectors using scan(), combine (c()), seq(), sequence operator (:), rep(). numeric vector, character vector, factors, converting numeric vectors into character vectors, converting character vectors into factors, checking variable types using class(), typeof(), is.numeric(), is.character(), is.factor(), arithmetic operations on vectors, printing vectors using print(), cat() functions.

Matrices: creating matrix using matrix(), creating identity matrix using diag(), creating null matrix using diag(), converting matrices into data frames using as.data.frame(), checking the dimensions of the matrix using dim(), nrow(), ncol(), extracting rows, columns or elements of matrix.

Data frames: creating data frames using data.frame(), converting data frames into matrices using as.matrix(), view data frames in a new window using View(), extracting variables from a data frame using $ and [ ], sub setting of data frames using subset() and [ ].

Lists: Creating lists, storing and extracting elements of lists, applying functions on list using lapply().

1.4 **R as a calculator**:

BODMAS rule.
Basic Mathematical functions: sqrt(), exp(), abs(), round() ceiling(), floor(), log(), log10(), sum(), prod(), cumsum(), cumprod(), min(), max(), diff(), sign(), pi, sort(), order(), etc.

Complex Numbers: complex(), is.complex(), as.complex(), Re(), Im(), Mod(), Arg(), Conj() etc.

Special Functions:
Trigonometric functions: sin(), cos(), tan() etc.
Set operations: union(), intersect(), setdiff(), setequal(), is.element(), %in%, all(), cross product of two sets.

Unit 2: Matrix Operations in R **(15 Hours)**

Matrix Manipulation: dim(), colnames(), rownames(), cbind() , rbind(), colSums(), rowSums(), colMeans(), rowMeans(), apply().

Arithmetic Operations on matrix: Addition, subtraction, multiplication of matrices, row sums and column sums of matrix, power of a matrix.

Matrix Product: matrix multiplication (%*%), crossprod(), Outer product (%o%).

Rank of matrix using rankMatrix(),transpose of a matrix using t(), Finding determinant of matrix using det(), finding inverse of matrix using solve(), trace of a matrix. verifying properties of trace of matrix and transpose of matrix, solving system of linear equations using solve().

Unit 3: Differentiation and Integration in R **(10 Hours)**

Defining mathematical functions in R, expression(), D(), deriv, eval(), numericDeriv(), integrate(), uniroot(), ysym(), Sym(), lim(), Limit().

Examples on differentiation and integration.

Solving polynomial equations using polyroot()

Unit 4: Data Visualisation in R **(15 Hours)**

Importing data available in .csv and .txt files into R,

Exporting outputs and base R datasets in .csv and .txt files from R.

Pie diagram for raw data and frequency table, Venn diagrams.

Barplot: simple barplot, subdivided barplot, multiple barplot.

Line plot for time series data, spike plot for discrete frequency distribution,

Histogram for raw data and continuous frequency distribution with equal and unequal class width.

Exporting plots and diagrams from R in MS-word.

Reference Books:

1. Long, J.D. Teetor P.(2019). R Cookbook (2nd Edition). O'Reilly Media, Inc.
2. Pfaff, T. (2019). R For College Mathematics and Statistics (first edition.). Chapman and Hall/CRC., New York.
3. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R (second edition). Narosa Publishing House, New Delhi.
4. Tilman M. Davies (2015). The Book of R: A First Course in Programming and Statistics (first edition). No Starch Press, USA.

Sites:

1) https://www.w3schools.com/r/
2) https://www.geeksforgeeks.org/r-tutorial/
3) https://www.tutorialspoint.com/r/index.htm

******

SEC-157: MTS Python-II

Course type: SEC **No. of Credits: 02(P)**

Course Objectives:

1. To give students an advanced introduction to Programming.
2. To learn and understand Python programming and paradigm.
3. To implement python program with dictionary and turtle
4. To understand the concept of 2D graphics
5. To understand the concept of files
6. To prepare the program for matrix and operations on it.

Course Outcomes:

1. To write python program and develop maps using dictionary
2. To develop logic for 2D graphics.
3. Demonstrate the use of Python in mathematics such as matrix algebra
4. To be familiar about basic math built in functions such as sine, cosine, etc.
5. To be familiar with complex numbers
6. To write Python programs to handle matrices and vectors using NumPy.

Course Content

Unit 1: Dictionaries **(08 Hours)**

1.1 Dictionary Literals

1.2 Adding Keys and Replacing Values

1.3 Accessing Values

1.4 Removing Keys

1.5 Traversing a Dictionary

-Practical 1 and Practical 2 based on unit 1.

Unit 2: Simple Graphics **(12 Hours)**

2.1 Overview of Turtle graphics

2.2 Turtle operations

2.3 Setting up a turtle.cfg file and running IDLE.

2.4 Object instantiation and the turtle module

2.5 Drawing two dimensional shapes

2.6 Examining an object's attributes

2.7 Manipulating a Turtle's screen

2.8 Taking a random walk

2.9 Colours and the RGB system

-Practical 3, Practical 4 and Practical 5 based on unit 2.

Unit 3: Complex Numbers in Python **(08 Hours)**

3.1 Introduction to complex numbers

3.2 Complex numbers with Python

-Practical 6 and Practical 7 based on unit 3.

Unit 4: File Handling **(08 Hours)**

4.1 Opening Files: File Modes

4.2 The basic file methods

- 4.2.1 Reading and Writing
- 4.2.2 Piping output
- 4.2.3 Reading and writing lines
- 4.2.4 Closing files
- 4.2.5 Using the basic files methods

4.3 Iterating over file content

- 4.3.1 One character at a time
- 4.3.2 One line at a time
- 4.3.3 Reading everything
- 4.3.4 Lazy line iteration with file input
- 4.3.5 File iterators

-Practical 8 and Practical 9 based on unit 4.

Unit 5: NumPy **(12 Hours)**

5.1 NumPy basics

5.2 NumPy arrays

5.3 Copying / Sorting

5.4 Array manipulation.

5.5 Mathematics

5.6 Basic Statistics

-Practical 10, Practical 11 and Practical 12 based on unit 5.

Unit 6: Matrix Algebra in Python **(12 Hours)**

6.1 Vectors

6.2 Matrices

6.3 Linear Algebra

6.4 Matrix addition

6.5 Matrix subtraction

6.6 Matrix multiplication

6.7 Transpose of a matrix.

6.8 Determinant.

6.9 Inverse matrix

- Practical 13 and Practical 14 based on unit 6.
- Practical 15 is based on unit 5 and 6.

Reference Books:

1. Fundamentals of Python first programs, 2nd Edition, Kenneth A. Lambert.
2. Beginning Python from Novice to Professional, Third Edition, Magnus Lie Hetland.
3. Python for Science and Engineering, Hans-Petter Halvorsen.
4. Python Programming: An Introduction to Computer Science, Third Edition, John Zelle.
5. Introduction to Scientific Computing in Python, Continuum Analytics and Robert Johansson.

******

MINORS FOR OTHER DECIPLINES AND OTHER FACULTY

(MTS-191 Minors for Computer Science, Commerce and Management, Social Sciences, Physical Sciences, Biomathematics, Competitive Exams and Pharmacy)

(Choose any one)

A student whose major is other than Mathematics can choose any one of these subjects as Minor subject.

A) Mathematics for Computer Science

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To introduce the concepts of mathematical logic.
2. To introduce the concepts of sets, relations, and functions.
3. To perform the operations associated with sets, functions, and relations.
4. To relate practical examples to the appropriate set, function, or relation model and interpret the associated operations and terminology in context.
5. To introduce application of logic gates in Computer science.
6. To learn the types and properties of Function.

Course Outcomes: The student will able

1. To apply mathematical logic to solve problems.
2. To understand sets, relations, functions and discrete structures.
3. To use logical notations.
4. To apply mathematical concepts such as sets, relations and functions.
5. To know the applications of Pigeon-Hole Principle.
6. To learn the types of relations.

Course Content

Unit 1: Sets **(06 Hours)**

1.1 Basic Definitions: Revision of sets, describing sets mathematically, special sets, set membership, equality of sets, finite and infinite sets, subsets, operations on sets, De Morgan's Laws, power sets, a computer representation for sets.

1.2 The Principle of Inclusion-Exclusion (for two and three sets only), addition and multiplication principles.

1.3 Mathematical Induction : The first principle of induction, constructing proofs by induction, applications of inductions.

Unit 2: Logic **(06 Hours)**

2.1 Introduction to propositional logic: Proposition, propositional connectives, truth tables, tautologies .

2.2 Inferences: Direct and indirect proofs to check validity of arguments.

2.3 Predicates and Quantification: Predicates, Quantification, Restricted Quantification, Nested Quantifiers, Negation and Quantification, Quantification with conjunction and disjunction

Unit 3: Relations **(10 Hours)**

3.1 Relations: Binary Relations, n-ary relations.

3.2 Operations on Binary Relations: Inverses, composition.

3.3 Special types of relations: Reflexive and irreflexive relations, symmetric and antisymmetric relations, transitive relations, reflexive, symmetric and transitive closures, applications of transitive closures in medicine and engineering.

3.4 Equivalence Relations, partitions.

3.5 Ordering Relations: Partial orderings, Linear orderings, Comparable elements, Optimal elements in orderings, Finding a minimal element.

3.6 Relational Databases: An Introduction, storing information in relations, relational algebra.

Unit 4: Functions **(08 Hours)**

4.1 Basic Definitions: Functions as rules, functions as sets, recursively defined functions, one-one and onto functions, increasing and decreasing functions.

4.2 Operations on functions: Composition of functions, inverses of functions.

4.3 The Pigeon-Hole Principle, Generalized Pigeon-Hole Principle, Applications.

Reference Books:

1. Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf Sue Whitesides.
2. Discrete Mathematics and its applications, by Kenneth Rosen (Tata McGraw Hill).
3. Discrete Mathematical Structures, by Kolman, Busby, Ross, Rehman (Prentice Hall).
4. Elements of Discrete Mathematics, by C. L. Liu (Tata McGraw Hill).

******

B) Mathematics for Commerce and Management

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To develop a foundation of mathematical concepts.
2. To understand and apply concepts of ratio, proportion, and percentage in various business contexts.
3. To understand and apply the concepts of profit, loss, commission, and discounts in sales scenarios.
4. To understand and apply the concepts of interest and annuities in various business contexts and personal finance.
5. To understand and apply concepts of shares and brokerage in financial planning and investment.
6. To apply mathematical techniques to solve real-world business problems.

Course Outcomes: The student will able

1. To understand the concepts of ratio, proportion, percentage, interest, annuity, shares.
2. To solve the problems using the concepts of ratio, proportion, percentage, interest, annuity, shares
3. To analyze financial problems using the concepts of ratio, proportion, percentage, interest, annuity, shares.
4. To evaluate financial conditions based on one's income/expenditure using the concepts of ratio, proportion, percentage, interest, annuity, shares.
5. To prepare monthly family budget based on one's income/expenditure using the concepts of ratio, proportion, percentage, interest, annuity, shares.
6. To have sufficient knowledge to manage personal finance.

Course Content

Unit 1: Elementary Mathematics **(06 Hours)**

1.1 Concepts of ratios, proportions and percentage. Examples and problems with applications in the field of commerce and management.

1.2 Real life applications and problem solving.

Unit 2: Financial Mathematics **(08 Hours)**

2.1 Concept of profit, loss and examples and problems.

2.2 Concepts of trade discount, cash discount, cost price, selling price, list price and marked price and examples and problems.

2.3 Concept of commission, types of commission, and examples and problems.

2.4 Application of profit and loss in real-life scenarios, Practice exercises and problem-solving.

Unit 3: Interest and Annuity **(10 Hours)**

3.1 Concepts of present value and future value, simple interest, compound interest, nominal and effective rate of interest, Examples and problems.

3.2 Ordinary annuity, sinking fund, annuity due, present value and future value of annuity, Equated Monthly Instalments (EMI) by method interest of reducing balance and flat interest rate methods. Examples and Problems.

Unit 4: Shares **(06 Hours)**

4.1 Concept of share, types of shares: preference shares and equity shares.

4.2 Definitions of face value, market value, dividend, brokerage, bonus shares, debentures.

4.3 Examples and Problems.

Reference Books:

1. Mathematics of Business and Finance, L. Daisley, T. Kugathasan, D. Huysmans, 4^{th} Edition, Vretta Inc. Canada.
2. Mathematics for Business, Gary Bronson, Richard Bronson, Maureen Kieff, 7^{th} Edition, MERCURY LEARNING AND INFORMATION, New Delhi.
3. A guide to business mathematics, Gerard O'Regan, CRC Press.
4. Theory and Problems of BEGINNING FINITE MATHEMATICS, SEYMOUR LIPSCHUTZ, JOHN J. SCHILLER, R. ALU SRINIVASAN, Schaum's Outline Series, New Delhi.

******

C) Mathematics for Social Sciences

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims to develop the basic mathematical skills of social science students. This topic is introduced to serve as basic tools for specialized studies. It also aims

1. To provide detailed of linear equation, graph and its applications.
2. To understand the inequalities and simple calculations.
3. To provide overview of non-linear equations, graphs.
4. To cover basic skill and concepts of logarithm and exponential and their uses.
5. To provide understanding of ratio, proportion.
6. To compute interest with illustrations.

Course Outcomes: The student will able

1. To understand techniques to draw graphs and solution of equations and apply to solve business, economics, and social sciences problems.
2. To perform the calculations using logarithms.
3. To learn application of appropriate techniques to obtain various functions, including logarithmic and exponential functions.
4. To understand the skill of ratio and proportion and their simple illustrations.
5. To understand the concept of interest and its computations.
6. To solve application problems on interest with emphasis on business and social sciences applications.

Course Content

Unit 1: Linear Equations **(06 Hours)**
Graphs, Solution of simultaneous equations, Supply and demand analysis.

Unit 2: Algebra **(06 Hours)**
Inequalities, Algebra of numbers, Transposition of formulae, National Income Determination.

Unit 3: Non-linear Equations **(09 Hours)**
Quadratic functions, Revenue, Revenue, cost and profit, Indices and logarithms, Exponents and Natural logarithmic functions.

Unit 4: Mathematics of Finanace **(09 Hours)**
Ratio, Proportion, Percentage, Simple and Compound interest, Annuity and its type.

Reference Books:

1. Mathematics for Economics and Business, Ian Jacques, 5^{th} Edition, Pearson Education Limited. (Chapter 1, 2, 3)
2. Mathematics for Business, Science, and Technology, Steven T. Karris, Third Edition, Orchard Publications.
3. Calculus for Business, Economics and Finance (Schaum's Outline), Luis Moises Pena-Levano, Fourth edition, McGraw Hill.
4. Practical Business Mathematics, S. A Bari, New Literature Publishing Company, Bombay, 1971.

******

D) Mathematics for Physical Science

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To impart the mathematical knowledge of set, relation, function, complex number, Boolean algebra and matrices to the students of physics, chemistry and electronics science.
2. To impart sufficient knowledge of fundamental principles, methods and mathematical ideas and tools to the students and know how to use them by solving and interpreting.
3. To apply the mathematics tools effectively in the field of physical sciences.
4. To Enhance students to equip them with mathematical problem-solving skills.
5. To impart the knowledge of matrices, operations on matrices and its properties and use them to solve problems in the field of physical sciences.
6. To impart the knowledge of Lattices, Boolean algebra and its properties and applicable in the field of physical sciences.

Course Outcomes: The student will able

1. To recall fundamentals of set, relation, complex numbers, Boolean algebra, matrices and identify basic geometrical figures, graphical representations of relation and function, complex numbers.
2. To get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.
3. To apply their skills and knowledge, that is, translate information presented verbally into mathematical form.
4. To use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.
5. To understand the matrix concept and operations on matrices.
6. To apply them for solving the problems in the field of physical sciences. Students be able to understand the concepts of lattices, Boolean algebra, Boolean function and logic, able to apply the concepts to solve problem in digital electronics and physics.

Course Content

Unit 1: Function **(06 Hours)**

1.1 Set, Relation, Equivalence relation.

1.2 Function, Domain, Co-domain, Types of functions.

1.3 Graph of Functions.

Unit 2: Complex Numbers **(08 Hours)**

2.1 Cartesian form of Complex numbers, Geometrical Representation.

2.2 Sums, subtraction, multiplication and division, Basic algebraic properties.

2.3 Polar form and properties of modulus and argument, Complex conjugates.

2.4 De-Moivre's theorem (statement and examples)

Unit 3: Boolean Algebra **(08 Hours)**

3.1 Partial ordering relations, Lattices -definition and elementary properties.

3.2 Principle of duality, Lattices as algebraic systems.

3.3 Distributive and complemented lattices.

3.4 Boolean Algebras, Uniqueness of finite Boolean algebras.

3.5 Boolean functions and expressions, Disjunctive normal form.

Unit 4: Matrices **(08 Hours)**

4.1 Matrices, operations on matrices.

4.2 Properties of matrix operations, Determinant.

4.3 Inverse matrix.

4.4 Elementary row and column operations, Echelon form of matrix.

Reference Books:

1. Introduction to Real Analysis by R.G. Bartle and D.R. Sherbert, John Wiley and Sons 4^{th} Edition. Unit-I.
2. Complex Variables and Application, James Ward Brown and Ruel V. Churchill, Mc-Graw Hill, 7^{th} Edition. Unit-II.
3. Introduction to Lattices and Order, B.A. Davey, H.A. Priestley, Cambridge University Press. Unit-III.
4. Elementary Linear Algebra, Application Version, Howard Anton, Chris Rorres, 9^{th} Edition. Unit-IV.
5. Mathematics for Chemistry,Kailas S. Ahire and Rajashri Sawant, Sahitya Sagar, Kanpur, 2023.

******

E) Biomathematics

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To gain an introductory understanding of matrix algebra.
2. To solve system of linear equations.
3. To understand the concept of derivative as a rate of change.
4. To help the students to build interest and confidence in learning application of mathematics for life science.
5. To understand the concept of central tendency.
6. To can learn the applications of Biomathematics.

Course Outcomes: The student will able

1. To understand the concepts of matrices, determinants
2. To learn the rank and type of matrices.
3. To develop mathematical ideas from a system of linear equations.
4. To solve the system of linear equations using the Gaussian elimination method.
5. To use in data analysis.
6. To prepare the real life models

Course Content

Unit 1: Matrices and Determinants **(10 Hours)**
Matrices. Definition, type of matrices, operations on matrices Determinants Definition up to order three, singular, non-singular matrices.

Unit 2: Rank and System of linear equations **(10 Hours)**
Rank. Elementary transformation, row echelon form of Matrix, rank of Matrix. System of linear equations, Gaussian elimination method, constructing linear models in biological systems, application of linear equation in biology.

Unit 3: Mathematical Statistics **(10 Hours)**
Mean , Mode, Median, concept and its applications

Reference Books:

1. Mathematics for biological science by Jagdish Arya and Ladner 1979 Prentice hall.
2. Mathematics for biological scientists, M. Aitken, B. Broadhursts, S. Haldky, Garland science 2009.
3. Introduction to Mathematics for life scientists 3^{rd} edition 1979 Edward Batschalet, Springers.
4. Mathematics for biological sciences Illustrated edition 1979 J. C. Acharya and R. Lardner, Prentice hall.
5. Mathematics and Statistics by S.G. Gupta and S.C. Malik.

******

F) Mathematics For Competitive Examinations

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To recall basic facts about mathematics
2. To display knowledge of conventions such as notations, terminology and state important facts resulting from their studies.
3. To get a relational understanding of mathematical concepts and concerned structures.
4. To follow the patterns involved, mathematical reasoning.
5. To get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.
6. To cater the need of the to acquaint them with frequently asked patterns in quantitative aptitude during various examinations and campus interviews.

Course Outcomes: The student will able

1. To understand the basic concepts of quantitative ability.
2. To acquire satisfactory competency in use of mathematical reasoning.
3. To develop theoretical, applied and computational skills.
4. To solve campus placements aptitude papers covering quantitative ability.
5. To compete in various competitive exams like Banking, CAT, CMAT, GATE, GRE, GATE, MPSC, UPSC etc.
6. To built up quantitative aptitude and personality development.

Course Content

Unit 1: Number System and Basic Numeracy (12 Hours)

1.1 Number Systems: Basic calculation (Addition, subtraction, multiplication and division) and simplification, BODMAS Rule, place value, Face value.

1.2 Test of divisibility, Least Common multiple (L.C.M.) and Highest Common Factor(H.C.F.).

1.3 Decimals and Fractions.

1.4 Simplification.

1.5 Powers, Square root and Cube root.

1.6 Logarithm.

1.7 Surds and Indices.

1.8 Percentage.

1.9 Average.

1.10 Problems on Ages.

1.11 Series Test: Odd Man Out and Series Completion.

Unit 2: Quantitative Ability (Applied Mathematics-I) (12 Hours)

2.1 Ratio and Proportion.

2.2 Mixtures and Allegations.

2.3 Partnership.

2.4 Profit and Loss.

2.5 Simple Interest and Compound Interest.

Unit 3: Quantitative Ability (Applied Mathematics-II) (06 Hours)

3.1 Time and Work: Problems on unitary methods, problems on alternate days and wages, problems on chain- Rule, problems on Pipes and Cisterns.

3.2 Speed, Time and Distance: Problems on average and relative speed, problems on train, boats and streams.

Reference Books:

1. Fast Track Objective Arithmetic by Rajesh Verma.
2. Handbook for Mathematics by Arihant Experts.
3. Quantitative Aptitude for Competitive Examinations by R. S. Aggarwal.
4. Objective Arithmetic (SSC and Railway Exam Special) by R.S Aggarwal.
5. Teach Yourself Quantitative Aptitude by Arun Sharma.

6. The Pearson Guide To Quantitative Aptitude For Competitive Examination by Dinesh Khattar.

7. Quantitative Aptitude for all Competitive Exam by Abhijit Gupta.

8. Mathematics Text Books by N.C.E.R.T. for standard 10^{th}, 11^{th} and 12^{th}.

******

G) Mathematics for Pharmacy

Course type: Minor **No. of Credits: 02**

Course Objectives: This course aims

1. To know the theory and their application in Pharmacy.
2. To solve the different types of problems by applying theory.
3. To appreciate the important application of mathematics in Pharmacy.
4. To understand the help in the field of Clinical Pharmacy.
5. To classify system of both Plants and Animals.
6. To know the theory of evolution.

Course Outcomes: The student will able

1. To apply mathematical concepts and principles to perform computations for Pharmaceutical Sciences.
2. To create, use and analyse mathematical representations and mathematical relationships.
3. To communicate mathematical knowledge and understanding to help in the field of Clinical Pharmacy.
4. To perform abstract mathematical reasoning.
5. To learn about Cell biology.
6. To know Anatomy and Physiology of plants and animals.

Course Content

Unit 1: Partial fraction **(06 Hours)**
Introduction, Polynomial, Rational fractions, Proper and Improper fractions, Partial fraction, Resolving into Partial fraction, Application of Partial Fraction in Chemical Kinetics and Pharmacokinetics.

Unit 2: Logarithms **(06 Hours)**
Introduction, Definition, Theorems/Properties of logarithms, Common logarithms, Characteristic and Mantissa, worked examples, application of logarithm to solve pharmaceutical problems.

Unit 3: Function **(06 Hours)**

Real Valued function, Classification of real valued functions.

Unit 4: Limits and continuity **(06 Hours)**

Introduction, Limit of a function, Definition of limit of a function ($\epsilon - \delta$ definition).

Unit 5: Matrices and Determinant **(06 Hours)**

Introduction matrices, types of matrices, operation on matrices, transpose of a matrix, matrix multiplication, determinants, properties of determinants, product of determinants, minors and co-factors, adjoint of a square matrix, singular and non-singular matrices, inverse of a matrix, solution of system of linear of equations using matrix method, Cramer's rule, characteristic equation and roots of a square matrix, Cayley-Hamilton theorem, application of matrices in solving Pharmacokinetic equations, Respiratory volumes.

Reference Books:

1. Differential Calculus by Shanthinarayan.
2. Pharmaceutical Mathematics with application to Pharmacy by Panchaksharappa Gowda D.H.
3. Higher Engineering Mathematics by Dr.B.S.Grewal.

******

GENERIC ELECTIVE (GE) / OPEN ELECTIVES (OE) FOR OTHER FACULTY

(OPEN ELECTIVE COURSES FOR THE STUDENTS OTHER THAN SCIENCE FACULTY)

A student whose major is other than the faculty of Science and Technology can choose as an Open Elective.

OE-105 MTS : Basic Mathematics- I

Course type: OE(T) **No. of Credits: 02**

Course Objectives:

1. To understand basic concepts of Mathematics.
2. To be able to use the language, symbols, and notation of Mathematics.
3. To develop Mathematical curiosity and acquire skills in problem solving.
4. To develop an appropriate understanding of how to use mathematics in real-world problems.
5. To cultivate the right understanding and regain numerical aptitude.
6. To develop a logical approach toward analytical approach data.

Course Outcomes: The student will able

1. To understand the concepts of numbers and integers and able to develop skills in basic operations of integers to cultivate the right understanding and regain numerical aptitude.
2. To understand concepts of H.C.F. and L.C.M. of numbers, square root and cube Root and ability to apply in real-world problems.
3. To understand concepts of ratio, proportion, percentage and be able to cultivate the right understanding regaining numerical aptitude.
4. To understand concepts of average, profit and loss develop a logical approach toward analytical approach to real-world problems
5. To provide a platform for the students to build the fundamentals of Basic Mathematics for competitive examination preparation strategy
6. To establish a framework for the students to help acquire the knowledge and expertise necessary to secure employment opportunities in the government sector

Course Content

Unit 1: Integers **(12 Hours)**

1.1 Introduction to number system, Basic operations of integers

1.2 Highest Common Factor (H.C.F.) and Least Common Multiple (L.C.M.)

1.3 Square root and cube Root

Unit 2: Ratio, Proportion and Percentage **(08 Hours)**

2.1 Introduction to ratio and proportion

2.2 Finding ratio and proportion

2.3 Types of ratios

Unit 3: Average **(04 Hours)**

3.1 Introduction to average

3.2 Finding the average

Unit 4: Profit and Loss **(06 Hours)**

4.1 Introduction to profit and loss

4.2 Finding profit and loss

Reference Book:
Quantitative Aptitude for Competitive Examination by Dinesh Khattar, Pearson India Education Services Pvt. Ltd., Fourth Edition.

******

OE-106 MTS: Applied Mathematics - I

Course type: OE(P) **No. of Credits: 02(P)**

Course Objectives:

1. To develop a strong understanding of Geometry.
2. To becomes Master of basic operations on numbers in different way.
3. To gain proficiency in working with Profit and loss.
4. To acquire a solid foundation of trigonometry.
5. To learn the simulation of data.
6. To develop problem-solving skills by applying operations.

Course Outcomes: The student will able to

1. Enhance mathematical reasoning and critical thinking.
2. Easily present the data graphically.
3. Have the knowledge of geometrical shapes and their equations.
4. Have Skills of comparison through diagrams and charts.
5. Got the business ability.
6. Achieve the techniques of finding area and volume.

Course Content

Unit 1: Mensuration **(08 Hours)**
Perimeter of circle, triangle, square and rectangle. Area of circle, square, rectangle and triangles. Surface area of cylinder, sphere, cube and cuboid. Volume of cube, cuboid, sphere, hemisphere, cylinder and cone.

Unit 2: Trigonometry **(08 Hours)**
Degree and radian, Trigonometric ratios and identities, Angle of elevation and depression, Height and distance problems.

Unit 3: Arithmetic **(08 Hours)**
Arithmetic Mean, Geometric Mean, Harmonic Mean, Ratio, Proportion, Percentage, Profit and Loss, Partnership, Brokerage, (True) Discount, Simple and Compound Interest, Time and Work, Distance

Unit 4: Data Interpretation **(06 Hours)**
Tabulation, missing data problem. Graphs and Charts - Table, Line, Bar and Pie.

Reference Books:

1. Objective Arithmetic, R S Aggarwal, S. Chand & Company Ltd.
2. Business Mathematics,S. K. Sharma and G. Kaur, Sultan Chand & Sons.
3. Business Mathematics-II Edition Q. Zameerddin, V. K. Khanna, S K Bhambri.

******

OE-155 MTS: Basic Mathematics - II

Course type: OE(T) **No. of Credits: 02**

Course Objectives:

1. To be able to use the language, symbols and notation of Mathematics.
2. To develop Mathematical curiosity.
3. To help them acquire skills in solving problems.
4. To develop an appropriate understanding of how to use mathematics in real-world problems.
5. To cultivate the right understanding and regain numerical aptitude.
6. To develop a logical approach toward analytical approach data.

Course Outcomes: The student be will able

1. To understand the concepts of Time, Work and Wages also be able to logical approach towards analytical approach data of real word problem
2. To understand concepts of Linear Equations and ability to solve examples in finding Age in past and future.
3. To understand concepts of Simple and Compound Interest and to develop Mathematical Competence.

4. To understand concepts of Mensuration and able to develop Mathematical competence in solving Problems.
5. To provide a platform for the students to build the fundamentals of Basic Mathematics for competitive examination preparation strategy.
6. To establish a framework for the students to help acquire the knowledge and expertise necessary to secure employment opportunities in the government sector.

Course Content

Unit 1: Time, Work and Wages **(12 Hours)**

1.1 Introduction to Time, Work and Wages

1.2 Finding Time and Amount of Work

1.3 Finding Speed, Distance and Time

1.4 Finding Speed of Boats and Stream

Unit 2: Problems on Ages **(06 Hours)**

2.1 Introduction to Linear Equations

2.2 Finding Age Some Years Ago, Present Age and Age Some Years hence

Unit 3: Simple Interest and Compound Interest **(06 Hours)**

3.1 Introduction to Simple Interest and Compound Interest

3.2 Finding Simple Interest

3.3 Finding Compound Interest

Unit 4: Mensuration **(06 Hours)**

4.1 Introduction to the Concept of Mensuration

4.2 Finding Area, Perimeter, and Some Basic Facts

4.3 Introduction to Solids and Cubes

4.4 Finding Surface Area and Volume

Reference Book:

Quantitative Aptitude for Competitive Examination by Dinesh Khattar, Pearson India Education Services Pvt. Ltd., Fourth Edition.

******

OE-156 MTS: Applied Mathematics - II
Title : Introduction to MS Excel

Course type: OE(P) **No. of Credits: 02(P)**

Course Objectives: This course aims on

1. Basic Essential Computing skills companies are looking for.
2. Hands-on Practical Knowledge.
3. Boosting their resume.
4. Providing an edge over other applicants in the competitive job market.
5. Providing valuable experience and confidence.
6. Heightening their earning potential.

Course Outcomes: The student will be able to

1. Create, save and print worksheets
2. Create formulas
3. Use functions for SUM, AVERAGE, MIN, and MAX
4. Use the function for IF
5. Format cells using many of the formatting tools
6. Present the Data Graphically

Course Content

Practical 1: The Excel environment
Navigating a worksheet
Spreadsheet terminology
Getting help

Practical 2: Entering and editing data
Entering and editing text and values
Entering and editing formulas
Saving and updating workbooks

Practical 3: Modifying a worksheet
Moving and copying data
Moving and copying formulas
Inserting and deleting ranges, rows, and columns
Cell comments

Practical 4: Using functions
Entering functions
AutoSum
Other common functions

Practical 5: Formatting
Text formatting
Row and column formatting
Number formatting
Conditional formatting
Additional formatting options

Practical 6: Printing
Preparing to print
Page Setup options
Printing worksheets

Practical 7: Charts
Chart basics
Column Chart
Pie Chart
Bar Chart
Pai Chart
Line Chart

Practical 8: Case Study
Modifying existing worksheet
Use shortcut keys
Create and email worksheet

Practical 9: Review Basics
Downloading from Account Reconciliation
The Excel environment
The Sparkline
The Trendline

Practical 10: Subtotal Functions
Create an outline and consolidate data
Create subtotals in a list
Use multiple subtotal functions- SUBTOTAL, SUMIF
Create custom views to save different sets of worksheet display and print settings

Practical 11: Range names and Filter date
Define and apply cell and range names
Use names in Formulas
Filter data based on complex criteria
Use conditional filters
Copy filtered results to another range

Practical 12: Pivot Tables
Prepare data in a table format and name the table
Create a PivotTable for analysing
Use the Download Actuals page in Account
Reconciliation as example
Modify or re-arrange fields

Practical 13: Selected Functions
Using IF and SUMIF functions to calculate a value based on specified criteria
Use ROUND function to round off numbers
Use VLOOKUP to find values in worksheet data
Use HLOO

Practical 14: Simulation
Scatter
Area
Stock
Surface
Rader

Practical 15: Applications
Applications of Ms-excel
business analysis
data entry and storage
data analysis
accounting and budgeting

Reference Book:

Beginning Excel 2019 by Noreen Brown; Barbara Lave; Hallie Puncochar; Julie Romey; Mary Schatz; Art Schneider; and Diane Shingledecker
Open Oregon Educational Resources

******