HSNC University Mumbai

(2023-2024)

Ordinances and Regulations

With Respect to

Choice Based Credit System

(CBCS)

For the Programmes Under

The Faculty of Science and Technology

For the Course

MATHEMATICS
Semester I, Semester -II

With effect from the Academic year 2023-2024

under NEP 2020

Board of Studies in Mathematics

1. **Name of Chairperson**
   Mrs. Usha G. Hemasundar ,Head, Department of Mathematics, M Sc Mathematics Associate Professor, K. C. College Ph: 9892234921 Email id: usha.gollakota@kccollege.edu.in

   Name of Co-Chairperson
   Ms. Shubhada Kanchan, MSc Mathematics,Department of Mathematics and Statistics Assistant Professor, H. R. College,Ph: 9975673087 Email id: shubhadark@yahoo.co.in

2. **Two to five teachers each having minimum five years teaching experience amongst the full-time teachers of the Departments, in the relevant subject.**
   a.) Dr. Pankit Gandhi, MSc (Mathematics), M Phil, Ph.D., LL.B., Associate Professor, K. C. College, Ph: 8169381936 Email id: pankit.gandhi@kccollege.edu
   b.) Mrs. Vijayalaxmi Suvarna ,M Sc Mathematics, M.Phil ,Assistant Professor,H. R. College, Ph: 9987395783; Email id: vijayalaxmi_suvarna@rediffmail.com
   c.) Mrs. Mrunal Hardikar ,M Sc Mathematic, Assistant Professor, K. C. College, Ph: 9653227252; Email id: mrunal.hardikar@kccollege
   d.) Mr. Nilesh Bhandarkar ,M Sc Mathematic, Assistant Professor, K. C. College, Ph: 98200868037; Email id:nilesh.bhandarkar@kccollege

3. **One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body; nominated by Parent Body;-**
   a.) Dr Sushil Kulkarni , Professor, Head, School of Mathematics,Applied Statistics &Analyticas,NMIMS
4. **External experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body**;
   a.) Dr Ajit Kumar , Ph.D. Mathematics,Associate Professor and Head, Department of Mathematics, Institute of Chemical Technology, Mumbai
   b.) Mrs. Jayashree Shetty, Associate Professor, KPB Hinduja College, Mumbai
   c.) Dr. Amiya Ranjan Bhowmick, Ph.D. Applied Mathematics and Statistics; Assistant Professor, Institute of Chemical Technology, Mumbai
   d.) Mr. Prashant Shukla,MSc statistics, Masters in Financial Management JBIMS; Chief Investment Officer, Aston Capital Advisor Pvt Ltd,Partner at HBD Consulting LLP
   e.) Mr. Nikunj Sharma ,Zonal Head, Tata Portfolio JLL,
   f.) Mr. Kaushal Shah,M.Com, PGDBA(Finance),Senior Manager, Treasury Reliance Power
   g.) Mr. Ravi Vyas ,Founder S.MONK School of Actuaries
5. **Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year.**

   Ms. Gunjan Shinde, B Sc, Mathematics, Currently pursuing online Degree in data Science and Programming from IIT ,Madras.

Preamble

The syllabus for major and minor courses in Mathematics are designed to lay a solid foundation for the undergraduate Mathematics student (Science Stream) in the two core aspects of Mathematics; viz the discrete and the continuous.

Discrete Mathematics involves the study of discrete objects; i.e. objects which are finite or can be enumerated by integers. It plays a foundational role in other branches of mathematics such as Number Theory, Linear Algebra, Abstract Algebra, Combinatorics, Graph Theory and Probability Theory. It also provides the mathematical foundation for many computer science courses such as data structures, automata theory, and compiler theory and computer security. The applications of Discrete Mathematics are spread across diverse areas such as Chemistry, Life Sciences, Business and Data Analysis.

While discrete means separate or distinct, continuous means without interruption or breaks. Continuous Mathematics provides excellent tools for analyzing real world phenomena that change smoothly over time. Traditional Geometry, Calculus, Real and Complex Analysis, Differential Equations, Differential Geometry, Topology and Functional Analysis are some of the branches of Mathematics which come under the banner of Continuous Mathematics. It is useful in the fields of Physics, Statistics, Economics, Finance, Artificial Intelligence, Biotechnology and Engineering.

A student who completes the minor course in Mathematics will be well equipped to understand the foundational concepts of Discrete Mathematics, Calculus and Linear Algebra which are applicable to other branches of sciences and humanities.
In addition, a student who completes the major course in Mathematics will enhance their knowledge in Pure Mathematics and develop their analytical thinking ability.

Curriculum Topics along with Self-Learning Topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT.
The course will be conducted through the medium of lectures along with practical /lab sessions. The course assessment will include team presentations/home assignment based on self-learning topics (SLE) as well as traditional semester end written examination.

Part1: Detail Scheme Theory
F.Y.B.SC. MATHEMATICS SYLLABUS
(SEMESTER BASED CREDIT AND GRADING SYSTEM)
IMPLEMENTED FROM THE ACADEMIC YEAR 2023-2024 under
NEP as an optional major as well as minor Course

Semester – I

The Scheme of Teaching and Examination

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Mathematics(Major/Minor Course)			MAT101B	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				
4	Vocational Course-Math Section			MAT103D	

First-year Semester-I Formative and Summative Assessment
Detail Scheme:

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	MAT101B	A Foundation Course in Mathematics - I	3	20% *	3	0	0	3	15	-	-	60	75
2	MAT101D	Practical based on a Foundation Course in Mathematics - I	1		0	0	1	1	-	-	-	25 (Practical Examination)	25
	Total Hours / Credit							04	Total Marks				100

One to two lectures to be taken for CONTINUOUS self-learning evaluation

Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours /Lectures	Total No. of hours/lectures	Credit	Total Marks
1	MAT101B	I	Ordinary Differential Equations	15	45 L	3	75 (60+15)
		II	Counting Principles	15			
		III	Integers and Divisibility	15			
2	MAT101D		Practical sessions based on MAT101B	30	30	1	25
			TOTAL			4	100

- **Lecture Duration – 60 Minutes = 1 Hour**
- **One Credit Theory=15 Hours**
- **One Credit Practical=30 Hours**

L: Lecture P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self-learning evaluation OBT -Open Book Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

Course Code: MAT101B
Title of course: A Foundation Course in Mathematics-I
Total credits: 04 (3T+ 1P)

Salient Features:

- In Unit 1, we focus on key concepts and methods of first order ordinary differential equations. Differential equations play a fundamental role in modern science where a differential equation is formulated to describe how a physical system changes in time. Applications of differential equations are found in Physics, Engineering, Chemistry, Biology, Economics and Finance.
- The most fundamental notion in mathematics is “Sets”. Based on the concept of sets, we have a detailed study of various Counting Principles in Unit 2. The ideas presented in this unit form an integral part of Combinatorics and is used extensively in computer science.
- In Unit 3, we focus on integers and their properties. The concepts discussed here find their applications in Computer Arithmetic and Cryptography.

Learning Objectives:

1. To introduce and provide the learner with fundamental concepts and applications of first order ordinary Differential Equation and Discrete Mathematics.
2. To develop pattern recognition and problem-solving skills of the learner.
3. To emphasize on understanding proofs, appreciate the language of proofs and developproof writing skills.

Course Outcomes:

1. Learner will be able to identify whether a differential equation is exact or non-exact, identify the most suitable method to find integrating factor for a non-exact equation, find solutions of first order differential equation and apply these ideas to formulate and solve differential equations arising naturally in basic sciences.
2. Learner will be able to interpret and solve problems using counting techniques based on addition and multiplication principles, pigeonhole principle and inclusion exclusion principleas well as problems based on permutations and combinations, binomial and multinomial theorems.
3. Learner will be able to apply Euclidean Algorithm and back substitution to find GCD oftwo integers, apply properties of modular arithmetic to find remainders and check for divisibility. Learner will be able to construct proofs using direct argument, contradiction, taking cases or mathematical induction as required.
4. Learner will improve his ability in solving problems based on logical reasoning and quantitative aptitude.

Evaluation Pattern:

The course will be assessed for a total of 100 marks and will consist of:

- **Summative Assessment** (End Semester Theory Exam): **60 marks**.
  Paper Pattern:

Q1: **Unit 1**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q2: **Unit 2**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q3: **Unit 3**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q4: **All three units**: (15 marks)

Attempt any five out of seven (3 marks each)

- **Formative Assessment: 40 marks.**

(Self-Learning Evaluation – 15 marks (assignment or group project) and Practical Exam – 25 mark

(Self-Learning Evaluation – 15 marks comprising of

- class assignment or home assignment or a case study or Group Presentation on SLE Topics (10 marks)
- Viva based on sle topics (5 marks)

Unit	Content	No. of Lectures
1	**1. Ordinary Differential Equations (ODE).** **1.1** Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and nonlinear ODE. Methods for solving first order ordinary differential equation. Method of variable separation. Homogeneous, nonhomogeneous differential equation **1.2** Exact equation ,General Solution of Exact equation of first order and first degree, Necessary and sufficient condition for M dx + N dy = 0 to be exact. Non-exact equations. **1.3** Integrating factors, Rules for finding integrating factors (without proof) for non-exact equations. **1.4** First Order linear Differential Equation, Bernoulli's equations. **1.5** Applications of first order ordinary differential equation.	**15**
2	**2. Counting Principles** 2.1 Addition and Multiplication Principles, counting sets of pairs, two-way counting. 2.2 Pigeonhole principle. 2.3 Inclusion-Exclusion Principle 2.4 Permutation and combination of sets and multi-sets, circular permutations. 2.5 Binomial Theorem, Pascal's identity, Multinomial Theorem.	**15**
3	**3. Integers and Divisibility** 3.1 Well Ordering Property (W.O.P) for $\mathbb{N}$ / $\mathbb{W}$. First principle of finite Induction, Second principle of finite Induction. 3.2 Divisibility in Z with properties and examples 3.3 G.C.D. and L.C.M of integers. Euclidean Algorithm. 3.4 Primes. Euclid's Lemma, Unique Factorization Theorem. Examples. 3.5 Congruences: Definition and elementary properties. Examples.	**15**

Practicals based on
Course Code: MAT101D

(15 practical sessions each of 2 lectures)

	Topics	Number of lectures
	P1 to P5: Practicals based on 1.1 to 1.5 **P6 to P10: Practicals based on 2.1 to 2.5** **P11 to P15: Practicals based on 3.1 to 3.5.**	30

Self-Learning topics (Unit wise)

Unit	Topics
1	1.1 Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and nonlinear ODE.
2	2.1 Addition and Multiplication Principles, counting sets of pairs, two way counting.
2	2.4, circular permutations.
2	2.5 Binomial Theorem, Pascal's identity
3	3.1 First principle of finite Induction

Online Resources

1.Basic Real Analysis' **by Prof. I K Rana , IIT Mumbai**
https://nptel.ac.in/courses/111/101/111101134/ lectures ,3,4,5,6
2.'Discrete Mathematics', by Prof. Sourav from Chennai Mathematical Institute, available on Swayam-NPTEL portal
https://nptel.ac.in/courses/111/106/111106086/
*Subject to change if any new relevant course is available.

Reference Books:

1. Differential equations with applications and historical notes, by G. F. Simmons, McGraw Hill (unit1)
2. An introduction to ordinary differential equations E. A. Coddington,
3. A Foundation Course in Mathematics: Ajit Kumar, S. Kumaresan, Bhabha Kumar Sarma,2018, Narosa Publishing House.
4. Discrete Mathematics: Norman L. Biggs, second Edition, Oxford University Press.
5. Elementary Number Theory: David Burton; Tata McGraw Hill.
6. Introductory Combinatorics : Richard Brualdi, John Wiley and sons.
7. Combinatorics-Theory and Applications: V. Krishnamurthy, Affiliated East West Press.

The Scheme of Teaching and Examination Semester – II

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Mathematics (Major/Minor Course)			MAT102B	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				
4	Vocational Course-Math Section			MAT104D	

First-year Semester-II Formative and Summative Assessment
Detail Scheme:

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	MAT102B	A Foundation Course in Mathematics - II	3	20% *	3	0	0	3	15	-	-	60	75
2	MAT102D	Practical based on a Foundation Course in Mathematics - II	1		0	0	1	1	-	-	-	25 (Practical Examination)	25
	Total Hours / Credit							04	Total Marks				100

One to two lectures to be taken for CONTINUOUS self-learning Evaluation

Semester – II Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours /Lectures	Total No. of hours/lectures	Credit	Total Marks
1	MAT102B	I	Relations and Functions	15	45 L	3	75 (60+15)
		II	Limits and Continuity of real-valued functions	15			
		III	Differentiation of real-valued function of one variable and Applications.	15			
2	MAT102D		Practical sessions based on MAT102B	30	30	1	25
			TOTAL			4	100

- **Lecture Duration – 60 Minutes = 1 Hour**
- **One Credit Theory=15 Hours**
- **One Credit Practical=30 Hours**

L: Lecture P: Practical T- Theory, Cp-Core Practical, SLE- Self-learning evaluation OBT - Open Book Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

Part2

Detail Syllabus: Semester II

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course Code: MAT102B
Title of course: A Foundation Course in Mathematics II
Total credits :04(3 T+ 1P)

Salient Features:

- In Unit 1, we will create a strong grounding in the topic of relations and functions. Functions are extremely significant in mathematics. We will study functions as a special type of relation and study different types of functions. The concept of relations is useful in learning Lattice theory, Boolean Algebra and Graph theory.
- In Unit 2, we focus on Continuity of functions, which is one of the core concepts in Calculus and Analysis. We will learn important properties of continuous functions on intervals of the real line and solve problems based on these properties.
- In Unit 3, we study differential Calculus which utilizes the idea of rate of change to understand the behavior of functions, such as stationary points, maxima and minima, increasing and decreasing nature of functions, concavity, convexity and point of inflection. The concepts studied here have their applications in physics, engineering, biology, economics, architecture and aviation.

Learning Objectives:

1. To introduce and provide the learner with fundamental concepts of Calculus and theconcepts of Relations and Functions.
2. To develop pattern recognition and problem-solving skills of the learner.
3. To develop the ability of applying concepts of Relations, Functions and Calculus.

Course Outcomes:

1. Learner will be able to determine whether a relation is a function and identify its domain and range, check for bijections and compute inverse of bijective functions, demonstrate competence with equivalence relations and use this concept to find partition of sets or equivalence classes, develop proficiency with the set Zn; which is fundamental in the study of finite arithmetic.
2. Learner will be able to apply the ϵ-δ notion of limits to derive properties of limits, continuity and applications of continuity of real valued functions.
3. Learner will be able to apply the concepts of differentiability to check the increasing or decreasing nature of functions, concavity or convexity, and find maxima and minima of functions. They will be able to distinguish between various mean-value theorems, solve various limit problems using L'Hospital's rule and apply Taylor's theorem to find series expansions and approximate values of standard functions.

4. Learner will start understanding mathematical foundations in the pure mathematics.

Evaluation Pattern:

The course will be assessed for a total of 100 marks and will consist of:

- **Summative Assessment** (End Semester Theory Exam): **60 marks**.
  Paper Pattern:

Q1: **Unit 1**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q2: **Unit 2**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q3: **Unit 3**: (15 marks)

A) Attempt any one out of two (7 marks each)
B) Attempt any two out of three (4 marks each)

Q4: **All three units**: (15 marks)

Attempt any five out of seven (3 marks each)

- **Formative Assessment: 40 marks.**

(Self-Learning Evaluation – 15 marks (assignment or group project) and Practical Exam – 25 mark

(Self-Learning Evaluation – 15 marks comprising of

- class assignment or home assignment or a case study or Group Presentation on SLE Topics (10 marks)
- Viva based on sle topics (5 marks)

Unit	Content	No. of Lectures
1	**Unit I: Relations and Functions** 1.1 Definition of a Relation with examples. Function as a Relation. Domain, co domain and the range of a function. Direct and inverse images. 1.2 Injective, surjective, and bijective functions. Composite and inverse functions. 1.3 Cross product of sets. Binary Operations 1.4 Equivalence relations and partitions. 1.5 Congruence relation as an equivalence relation on $\mathbb{Z}$. The set $\mathbb{Z}_n$, (of residue classes modulo n) under addition and multiplication modulo n.	**15**
2	2.1 Graphs of some standard functions such as absolute value function, x^2, $ax^2 + bx + c$, $\frac{1}{x}$, e^x, $logarithmic\ function$, tan x, sin x, cosx, $\sin^{-1}x$, x $\sin\frac{1}{x}$, $x^2\sin\frac{1}{x}$ over suitable intervals of $\mathbb{R}$. 2.2 Definition of Limit of a function, Definition of Continuous functions using left-hand limit, right-hand limit. 2.3 The $\varepsilon-\delta$ definitions of limits and continuity, Evaluation of limit of simple functions using the $\varepsilon-\delta$ definition, uniqueness of limit if,exists, 2.4 Continuity of a real valued function on a set in terms of limits, Geometric Interpretation of continuity, examples, Continuity of a real valued function at end points of domain. 2.5 Boundedness theorem, Minimax Theorem, Intermediate value theorem (Statements without proof) and applications.	**15**
3	3.1Review of limit definition of differentiation of real valued function of one variable. Algebra of differentiable functions. Definition of differentiation at a point of an open interval using $\varepsilon - \delta$, one sided derivative. 3.2 Examples of differentiable and non-differentiable functions, differentiable functions are continuous but not conversely, chain rule, Derivative of inverse functions, Higher order derivatives, Leibnitz rule, Implicit differentiation. 3.3 Local maximum and local minimum, Absolute maximum, Absolute minimum, stationary point, critical points, second derivative test, examples, graphing of functions using first and second order derivatives, convex curve, concave curve, points of inflection. 3.4 Rolle's theorem, Lagrange's and Cauchy's mean value theorems, applications and examples, Monotone increasing and decreasing function, examples. 3.5 L-Hospital rule without proof, Taylor's theorem and its applications.	**15**

Practicals based on Foundation Course in Mathematics II

Course Code:MAT102D

(15 practical sessions each of 2 lectures)

	Topics	Number of lectures
	P1 to P5: Practicals based on 1.1 to 1.5 **P6 to P10: Practicals based on 2.1 to 2.5** **P11 to P15: Practicals based on 3.1 to 3.5.**	30

Self-Learning topics (Unit wise)

Unit	Topics
1	1.1 Domain, co domain and the range of a function. Direct and inverse images. 1.2 Injective, surjective, and bijective functions. Composite and inverse functions
2	2.1. Definition of Limit of a function, Definition of Continuous functions using left-hand limit, right-hand limit.
3	3.1 Review of limit definition of differentiation of real valued function of one variable. Algebra of differentiable functions, one sided derivative.

.Online Resources

1.Basic Real Analysis by Prof Rana ,IIT Baomay,
https://nptel.ac.in/courses/111/101/111101134/
2"Calculus of One Real variable" by Prof Joydeep Dutta, IIT Kanpur
https://nptel.ac.in/courses/109/104/109104124/Week1 lecture5,week 2 lectures1,2,3,4.
3. 'Discrete Mathematics', by Prof. Sourav from Chennai Mathematical Institute, available on Swayam-NPTEL portal
https://nptel.ac.in/courses/111/106/111106086/

Reference Books:

1. Introduction to Real Analysis, John Wilely & Sons, 1994 by.R. G. Bartle-D. R. Sherbert, Chapter 4,5, (unit1) Chapter6:6.1(unit 2) 6.2,6.3,6.4(unit3)
2. A Basic Course in Real Analysis, Ajit kumar, S. Kumaresan, CRC Press, 2014.
3. Thomas' Calculus by Weir, Hass, Giordano, *Eleventh Edition*, Pearson
4. Kenneth H. Rosen: Discrete Mathematics and Its Applications, McGraw Hill Edition.
5. Norman Biggs: Discrete Mathematics, Oxford University Press.
6. Bernard Kolman, Robert Busby, Sharon Ross: Discrete Mathematical Structures, Prentice-Hall India.

Part 3.

Syllabus for Vocational Course

For F Y B Sc, Mathematics

Semester I

Course Title: An Introduction to Python, Sage Math, Geo Gebra

Course code: MAT103D

Total credits:01

Scheme of Teaching: Total 15 practical sessions of 1 hour duration shall be conducted.

Course Objectives:

1. To teach students the basics of Sage Math, Geo Gebra, Python.
2.To train students to use CAS in mathematical problem solving for the topics taught in the Foundation Course of Mathematics-I , taught as Major/Minor Course in Semester-I

Learning Outcomes:

1. The students will learn basics of Python programming.
2 The students will know how Sage Math, Geo Gebra can be used for Mathematical problem solving.

Evaluation Pattern:

The course will be assessed for a total of 25 marks and will consist of:

- Journal consisting of output of at least 9 practicals – 5 marks.
- Practical examination at end of Semester – 20 marks

Note:

1. One practical will be of one hour each
2. A practical batch will according to the university norms.
3. Students will maintain a file/journal in which the practical questions and the output obtained in the practicals will be filed.

Detailed Syllabus

Topics	Content	No. of Practicals
I	An Introduction to Geo Gebra: Objects, Tools and Commands, Using Sage Math for algebraic and numerical calculations	2
II	An introduction to Computing: Flowcharts, Algorithms, programs. Variables, expressions and statements, Logical operators and conditional statements in Python.	3
III	Recursions and Iterations. Strings, Lists and Tuples. An introduction to NumPy and SymPy.	4
IV	An introduction to Matplotlib, Sketching and visualizing data and functions.	2
V	Modelling a first order differential equation, solution and interpretation using Geo Gebra.	1
VI	**Revision / Extra Practical.**	3

List of Practicals: (Duration 1 Hour)

P1: An Introduction to Geo Gebra: Objects, Tools and Commands.
P2: Using Sage Math for algebraic and numerical calculations.
P3: An introduction to Computing: Flowcharts and the way to the program.
P4: Variables, expressions and statements in Python.
P5: Logical operators and conditional statements in Python.
P6: Recursions and Iterations.
P7: Strings, Lists and Tuples.
P8: An introduction to NumPy.
P9: An Introduction to SymPy.
P10: An introduction to Matplotlib I.
P11: An introduction to Matplotlib II.
P12: Modelling a first order differential equation, solution and interpretation using Geo Gebra.

Three more Practical sessions will be allotted for revision.

Reference Book:

1. Numerical Python: Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib by Robert Johnson, Second Edition, Apress.
2. Mathematical Modeling Applications with Geo Gebra by Jonas Hall and Thomas Lingerfjard, Willey.
3. A student's guide to the study, practice, and tools of Modern Mathematics by Donald Bindner and Martin Erickson, CRC Press Taylor & Francis Group.
4. Geo Gebra Manual: The official manual of Geo Gebra.

Online Resources

1.Numerical Methods by Prof. Ameeya Kumar Nayak, Prof. Sanjeev Kumar by IIT Roorkee https://nptel.ac.in/courses/111/107/111107105/unit8 lecture1,2,3,4
2.Computational Mathematics with Sage Math by Dr. Ajit Kumar, Institute of Chemical Technology, Mumbai NPTEL :: Mathematics - NOC:Computational Mathematics with SageMath
Subject to change if any new relevant course is available

Outcomes:

1. Student will be able to model and solve problems using CAS
2. Students will be able to write algorithms for some basic operations and execute those using Python.
3. Students will be able to apply numerical techniques for solving equations.

Online References

1. https://ajitmathsoft.wordpress.com/sagemath/

2.Computational Mathematics with Sage Math by Dr. Ajit Kumar, Institute of Chemical Technology, Mumbai NPTEL :: Mathematics - NOC:Computational Mathematics with SageMath

Part4
Syllabus for Vocational Course

For F Y B Sc, Mathematics

Semester II
Course Title: Numerical Techniques with Python Programming
Course code: MAT104D
Total credits:01

Scheme of Teaching: Total 15 practical sessions of 1 hour duration shall be conducted.

Course Objectives:

1 .To learn basic numerical techniques for the computation of approximate solutions of equation $f(x) = 0$ and of the first order of ordinary differential equation.
2. To train students in using Python programming for Numerical Techniques

Course Outcomes:
1. The students will apply various Numerical Techniques
2. The students will be able to execute Python programs to get approximate solutions for mathematical problems.

Evaluation Pattern:
The course will be assessed for a total of 25 marks and will consist of:

- Journal consisting of output of at least 9 practicals – 5 marks.
- Practical examination at end of Semester – 20 marks

Note:

1. One practical will be of one hour each.
2. A practical batch size will be according to the university norms.
3. Students will maintain a file/journal in which the practical questions and the output obtained in the practicals will be filed.

Detailed Syllabus

Topic	Content	No. of Practicals
I	Curve sketching, tracing and analyzing real functions for continuity and differentiability.	2
II	An introduction to numerical methods, Bisection and Newton-Raphson methods, implementation using Python.	5
III	Euler's method and Runge Kutta method. Implementation using Python.	4
IV	Working with Matrices using Python.	1

V	**Revision / Extra Practicals**	3

List of Practicals:

P1: Sketching and analyzing the graphs of real functions.

P2: Curve tracing- Creating animated curves using Matplotlib.

P3: An Introduction to Numerical Methods.
P4: Bisection Method to solve Equation f(x)=0 using scientific calculator.

P5: Bisection Method: Implementation using Python.
P 6: Newton Raphson's Method to solve Equation f(x)=0 using scientific calculator.

P 7: Newton Raphson's Method: Implementation using Python.
P8: Euler's method: using scientific calculator.

P9: Euler's method: Implementation using Python.

P10: Runge-Kutta Methods: using scientific calculator.

P11: Runge-Kutta Methods: Implementation using Python.

P12: Working with Matrices using Python.

Three more Practical sessions will be allotted for revision.

Reference Book:

1. Numerical methods by E Balaguruswamy, McGraw Hill.
2. Numerical Python: Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib by Robert Johnson, Second Edition, Apress.
3. Mathematical Modeling Applications with Geo Gebra by Jonas Hall and Thomas Lingerfjard, Willey.
4. A student's guide to the study, practice, and tools of Modern Mathematics by Donald Bindner and Martin Erickson, CRC Press Taylor & Francis Group.
5. Geo Gebra Manual: The official manual of Geo Gebra.

Online Resources

1.Numerical Methods by Prof. Ameeya Kumar Nayak, Prof. Sanjeev Kumar by IIT Roorkee https://nptel.ac.in/courses/111/107/111107105/unit8 lecture1,2,3,4
2.Computational Mathematics with Sage Math by Dr. Ajit Kumar, Institute of Chemical Technology, Mumbai NPTEL :: Mathematics - NOC:Computational Mathematics with SageMath
Subject to change if any new relevant course is available

Part 5
Syllabus for Vocational Course
FYBCom/FYBMS/FYBAF/FYBBI/FYBFM
Financial Mathematics and Statistics using MS-Excel
Course of 1 credit: 30 Practical hours

Semester I

Course Objectives:

- To develop an understanding of MS-Excel
- To develop the ability to construct and interpret diagrams and graphs which are applicable to real life in the fields of commerce, economics and management.
- To learn to convert the given mathematical and statistical problems into data in MS-Excel and then apply functions and commands to get the desired solutions.

Learning Outcomes: At the end of the course, students will be able to

- use Ms-Excel fairly easily
- represent data using frequency tables, graphs and diagrams.
- solve mathematical and statistical problems easily using the software through hands on training during the practicals.

Scheme of Teaching: Total 15 practical sessions of 2 hour duration shall be conducted.

Evaluation Pattern:
The course will be assessed for a total of 25 marks and will consist of:

- Journal consisting of output of at least 9 practicals – 5 marks.
- Practical examination at end of Semester – 20 marks

Note:

1. Each practical will be of two hours duration.
2. A practical batch size will be as per the university norms.
3. The students will have to maintain a file/journal in which the practical questions and the output obtained in the practicals should be filed.

Detailed Syllabus for Semester I

Unit	Content	No. of Practicals
I	**Introduction to Excel** 1.1 Workbook, worksheets, cells, types of data, cell references, cut, copy, paste (paste-special, values, formulas), conditional formatting 1.2 Operators- Arithmetic operators, Relational operators, Logical operators, creating formulas, functions, working with excel sheets – freeze panes, sort, custom sort, filter, find and replace, IF and Nested IF functions.	3
II	**Time value of money, annuities and loan amortization** 2.1 Compound interest, discrete and continuous compounding, nominal and effective rate of interest	3

	2.2 Regular annuity, future and present value of annuity, equated monthly instalments, amortization.	
III	**Matrices, simultaneous equations, LPP** 3.1 Matrices types, operations on matrices – scalar multiplication, addition, subtraction, product of matrices, determinants, inverse of a matrix 3.2 Simultaneous Equations construction and solving 3.3 Linear Programming Problems in two variables, formulation of LPP and solving graphically	3
IV	**Data representation using diagrams** 4.1 Constructing frequency tables 4.2 Making bar charts, pie charts and histograms	3
V	**Revision / Extra Practicals**	3

List of Practicals:

1. Working with Excel sheets.
2. Conditional Formatting, Sort and Filter.
3. Working with Formulas and Logical Operators.
4. Time Value of Money.
5. Annuities.
6. Loan Amortization.
7. Working with Matrices I
8. Working with Matrices II
9. Simultaneous Equations.
10. Linear Programming Problems.
11. Data Representation using Diagrams I
12. Data Representation using Diagrams II

Semester II

Course Objectives:

- To teach basic statistical measures with problem solving manually as well as using Excel.
- To teach how various statistical techniques with Excel can be effectively used in solving problems of economics and finance which results in making better decisions.

Learning Outcomes: At the end of the course, student will be able to

- calculate measures of central tendency and measures of dispersion through excel which can be useful in research
- find relationships between variables which can be used for forecasting.

- **Scheme of Teaching: Total 15 practical sessions of 2 hour duration shall be conducted.**

Evaluation Pattern:

The course will be assessed for a total of 25 marks and will consist of:

- Journal consisting of output of at least 9 practicals – 5 marks.
- Practical examination at end of Semester – 20 marks

Note:

1. Each practical will be of two hours duration.
2. A practical batch size will be as per the university norms.
3. The students will have to maintain a file/journal in which the practical questions and the output obtained in the practicals should be filed.

Detailed Syllabus

Unit	Content	No. of Practicals
I	**Measures of Central Tendency** 1.1 Mean 1.2 Median, Quartiles Deciles and Percentiles 1.3 Mode	3
II	**Measures of Dispersion** 2.1 Range and coefficient of range 2.2 Quartile Deviation and coefficient of quartile deviation 2.3 Mean Deviation and coefficient of mean deviation 2.4 Standard deviation and coefficient of variation	3
III	**Correlation and Regression** 3.1 Scatter plot, Karl Pearson's formula, Rank Correlation, Spearman's coefficient 3.2 Linear Regression, forecasting	3
IV	**Time Series and Index Numbers** 4.1 Time Series Analysis, forecasting using time series 4.2 Index Numbers unweighted and weighted, Laspeyre, Paasche, Fischer, Marshall-Edgeworth and Dorbish-Bowley index numbers	3
V	**Revision / Extra Practicals**	3

List of Practicals

1. Mean, Median and Mode.
2. Quartiles, Percentiles and Deciles.
3. Range, Quartile Deviation and their coefficients
4. Mean deviation from mean, median, mode and their coefficients
5. Standard deviation, variance, coefficient of variation
6. Scatter plots
7. Karl Pearson and Spearman's coefficients
8. Plotting linear equations
9. Linear Regression
10. Calculating moving averages
11. Forecasting using time series
12. Index numbers

Reference Books:

1. Microsoft Excel 2016 Bible by John Walkenbach, Wiley India
2. Microsoft Excel 2016 for Dummies by Greg Harvey, Wiley
3. Excel 2016 from scratch: Excel Course with Demos and Exercises by Peter Kalmstrom and Kate Kalmstrom
4. Mathematics for Economics and Finance Methods and Modelling by Martin Anthony and Norman Biggs, Cambridge University Press
5. Business Mathematics by D.C.Sancheti and V.K.Kapoor, Sultan Chand & Sons
6. Mathematics for Business and Economics by J.D.Gupta, P.K.Gupta and ManMohan, TataMc-Graw Hill Publishing Co.Ltd.
7. Quantitative Methods-Part-I by S.Saha and S.Mukerji, New Central Book Agency
8. Investments by J.C.Francis & R.W.Taylor, Schaum's Outlines, Tata Mc-GrawHill
9. Operations Research by Gupta and Kapoor
10. Statistical Methods by S.G.Gupta, S.Chand &Co
11. Statistics for Management by Levin & Rubin, Prentice Hall of India
12. Statistics - Theory, Method & Applications by D.S.Sancheti & V.K.Kapoor
13. Modern Business Statistics (Revised) by B.Pearles & C.Sullivan –Prentice Hall of India.
14. Business Mathematics & Statistics by B Aggarwal, Ane Book Pvt.Limited

Software Requirement:

Microsoft Excel 2016 or above

Part 6
Syllabus for General Elective -1
Offered by BoS (Mathematics)

General Elective -1 (Semester I)

GE Course Preamble:

In today's world, many graduate students are required to give some form of competitive exam to pursue higher studies or apply for jobs. Logical reasoning and quantitative aptitude are two basic skills that higher institutes and prospective employers expect from the student applicant. By offering this course we wish to inculcate these skills in our students so that they are prepared for such exams alongside their regular studies.

Semester-I

Course Title: Logical Reasoning and Quantitative Aptitude I
Course Code: MAT101C
Credits: 2

Course Objectives:

1. Learners will develop strong skills in critical and logical thinking.
2. Learners will understand the historical evolution of numbers and appreciate the beauty of their patterns.

Course Outcome:

1. Learners will be able to apply thinking skills to identify logical fallacies in the content spread by media, make wise personal decisions and be a well-informed citizen.
2. Learners will be able to use their knowledge of numbers to solve many real-life problems and recognize number patterns. They will also use various counting techniques to effectively count the number of possibilities with the given condition.

Evaluation Pattern:

The course will be assessed for a total of 50 marks and will consist of:

- **Summative Assessment** (End Semester Theory Exam): **30 marks**.

  Paper Pattern:

  Q.1: Both the units
  Attempt any five out of eight (2 Marks each)

  Q2 : **Unit 1**:
  Attempt any two out of four (5 marks each)

  Q3 : **Unit 2**:
  Attempt any two out of four(5 marks each)

- **Formative Assessment: 20 marks.**
  (Self-Learning Evaluation – 15 marks (Can be in the form of a class assignment or a home assignment or a case study) and Class performance – 5 marks)

Detailed Syllabus

Unit	Content	No. of Lectures
1	**1. Logic, Sets and Venn Diagrams** **1.1** Propositions, truth values and implications. **1.2** Logical equivalence, Tautology, Contradiction and contrapositive statements. **1.3** Inductive and deductive proofs. **1.4** Sets, compliment, union and intersection. **1.5** Venn diagrams	**15**
2	**2. Numbers in real world** 2.1. Integers, fractions, ratio and proportion, unit conversion. 2.2. Irrational numbers, π, $\sqrt{2}$, working with surds, concept of infinity. 2.3. Exponents, powers of 10 and logarithms. 2.4. Counting Techniques: Addition and multiplication principle, Inclusion-Exclusion principle.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
2	2.3 Exponents
2	2.5. Counting Techniques: Addition and multiplication principle, Inclusion-Exclusion principle.

Resources for Self-Learning

1. Using and Understanding Mathematics: A quantitative Reasoning Approach: 7th edition – Bennett and Briggs (Pearson) Chapter 2.
2. The Art and Craft of problem-solving (Second edition) – Paul Zeitz (John-Wiley & Sons, Inc) Chapter 6

Reference Books

1. Mathematics for the nonmathematician – Morris Kline (Dover Publications) (Chapters 3,4)
2. Using and Understanding Mathematics: A quantitative Reasoning Approach: 7th edition – Bennett and Briggs (Pearson) (Chapters 1,2,3)
3. Professor Stewart's Incredible Numbers- Ian Stewart (Profile Books) (Chapters 1,2,0, $\frac{1}{2}$, $\sqrt{2}$, π)
4. One Two Three … Infinity – George Gamow (Dover Publications) (Chapters 1 and 2)
5. The art of problem solving: Introduction to Algebra – Richard Rusczyk (AoPS) (Chapters 6 and 7).
6. Mathematical Reasoning: Writing and Proof Version 2.1 – Ted Sundstorm (Creative Commons) (Chapters 1,2,5)
7. The art of problem-solving Volume 1: The Basics- Sandor Lechoczky, Richard Rusczyk (AoPS Incorporated) (Chapters 1,4,8,25,27)
8. The Art and Craft of problem-solving (Second edition) – Paul Zeitz (John-Wiley & Sons, Inc) (Chapters 2, 5 and 6)

9. How the Other Half Thinks: Adventures in Mathematical Reasoning – Sherman Stein (Chapter 7)

Part 7
Semester II
General Elective -I
Course Title: Logical Reasoning and Quantitative Aptitude II
Course Code: MAT102C
Credits: 2

Course Objectives:
1. Learners will develop the skill to read news reports of statistical studies involving tables, charts and graphs.
2. Learners will be introduced to basic ideas of probability.

Course Outcome:
1. Learners will be able to read news reports of statistical studies in a way that will allow them to evaluate them critically and decide whether and how they affect learner's personal beliefs.
2. Learners will be able to quantify risks and uncertainties in real-life, required to make optimal decisions.

Evaluation Pattern:
The course will be assessed for a total of 50 marks and will consist of:

- **Summative Assessment** (End Semester Theory Exam): **30 marks**.
  Paper Pattern:

Q.1: Both the units Attempt any five out of eight (2 Marks each) Q2 : **<u>Unit 1</u>**: Attempt any two out of four (5 marks each) Q3 : **<u>Unit 2</u>**: Attempt any two out of four(5 marks each)

- **Formative Assessment: 20 marks.**
  (Self-Learning Evaluation – 15 marks (Can be in the form of a class assignment or a home assignment or a case study) and Class performance – 5 marks)

Detailed Syllabus

Unit	Content	No. of Lectures

1	**1. Statistical Reasoning** 1.1 Fundamentals of statistics, Population, Sample, Sample Statistics, Steps in Statistical study. 1.2 Common sampling methods. 1.3 Surveys and opinion polls. 1.4 Statistical tables and graphs (Bar graphs, Pie Charts, Histograms and Line graphs) 1.5 Graphics in Media: Few Cautions	**15**
2	**2. Probability: Language of uncertainty** 2.1. Experiment, Outcome, event, Expressing probability as a fraction, Probability of compliment. 2.2. Independent events, Dependent events. 2.3. Non-overlapping events, addition principle, at least and at most concepts 2.4. Expected values, Lottery expectations, Auctions. 2.5. Putting Probability and statistics together: Assessing risk, Life expectancy, law of large numbers, Probability distributions (concept)	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1	1.3 Surveys and opinion polls.
2	2.6 Lottery expectations, Auctions.

Resources for Self-Learning

Using and Understanding Mathematics: A quantitative Reasoning Approach: 7th edition – Bennett and Briggs (Pearson) Chapter 5

Reference Books

1. Mathematics for the nonmathematician – Morris Kline (Dover Publications) (Chapters 22,23)
2. Using and Understanding Mathematics: A quantitative Reasoning Approach: 7th edition – Bennett and Briggs (Pearson) (Chapters 5,7)
3. Mathematics of choice: How to count without counting – Ivan Niven (Random House) (Chapters 2 and 3)
4. The art of problem-solving Volume 1: The Basics- Sandor Lechoczky, Richard Rusczyk (AoPS Incorporated) (Chapter 26)