Shri Manibhai Virani and Smt. Navalben Virani Science College (Autonomous), Rajkot

Affiliated to Saurashtra University, Rajkot

11th AC held on 20th June, 2023

APPENDIX J.1

Enclosures I to V of 12th BoS Mathematics, 22nd May, 2023

Enclosure–BMTI

Sarvodaya Kelavani Samaj Managed

Shri Manibhai Virani & Smt. Navalben Virani Science College, Rajkot

(An autonomous College affiliated to Saurashtra University, Rajkot)

Reaccredited at the "A" Level (CGPA 3.28) by NAAC

"STAR" College Scheme & Status by MST-DBT

A College with Potential for Excellence – CPE (Phase - II) by UGC

Accredited at the G-AAA Highest Grade 'A-1' Level by KCG, Govt. of Gujarat

UGC-DDU KAUSHAL Kendra

GPCB-Government of Gujarat approved Environmental Audit Centre

SCHEME OF LEARNING AND EVALUATION

(In light of UGC's LOCF and NEP-2020)

of

B. Sc. MATHEMATICS

(w.e.f 2021-22)

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
(An Autonomous College affiliated to Saurashtra University, Rajkot)

Department of Mathematics

B.Sc. Mathematics

Vision of the Department:
To be recognized for excellence in Teaching – Learning adjunct by empowering graduating students to compete in and contribute to the developing needs of the society.

Mission of the Department:
To provide quality teaching-learning, research and service opportunities leading to holistic development of students through collegial exchange of ideas, independent thought, and the highest ethical standards.

Goals:

a. Provide high quality academic experiences through comprehensive & relevant curriculum at all UG & PG levels.

b. Foster problem solving ability and research aptitude by extending instructional and infrastructural support and research guidance.

c. Inculcate the values of multi-disciplinary approach and innovative thinking by facilitating learning experiences in the field of mathematics and its allied fields

d. Produce graduates with ability to solve real life problems and ability to face the emerging challenges for careers in academia, industry and GOs/NGOs.

e. Promote ethical and professional environment amongst faculties and students of the department.

GRADUATE ATTRIBUTES

- **Academic excellence**: Ability to identify key questions, research and pursue rigorous evidence-based arguments
- **Critical Thinking and Effective communications:** Analysis and evaluation of information to form a judgment about a subject or idea and ability to effectively communicate the same in a structured form.
- **Global Citizenship:** Mutual understanding with others from diverse cultures, perspectives and backgrounds
- **Life Long Learning:** Open, curious, willing to investigate, and consider new knowledge and ways of thinking

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) FOR B. Sc. MATHEMATICS

Our programme will produce Graduates who will attain following PEOs after few years of graduation

PEO 1 : **Core competency:** will develop the competency to pursue higher education or successful professional career with synergistic combination of the knowledge and skills of mathematics and allied sciences.

PEO 2 : **Breadth of knowledge:** will show capabilities of independently designing, executing and interpreting mathematical problems by integrating the interdisciplinary knowledge of Mathematics and other domains.

PEO 3 : **Preparedness:** will reflect professional behaviour and have the potential to show preparedness to take any task or assignment in the capacity of a leader or team member in their chosen occupations or careers and communities.

PEO 4 : **Professionalism:** will reflect values and responsibilities in the character to make them fit to work in a multidisciplinary team and to become socio-ethically responsible citizen.

PEO 5 : **Learning environment:** will show attitude of self-learning abilities and keep themselves abreast with new development in all spheres of life.

PROGRAM OUTCOMES (POs) FOR B. Sc. MATHEMATICS

After completion of the programme the Graduate will be able to:

PO 1 : **Domain knowledge:** Demonstrate the knowledge of concepts, principles and applications of Mathematics in various fields.

PO 2 : **Problem analysis:** Acquire critical thinking skills to understand and solve contemporary problems with knowledge and skills.

PO 3 : **Design/development of solutions:** Make decisions to develop solutions to given situations/questions, formulate strategies to identify, define and solve problems including, as necessary, global perspectives.

PO 4 : **Conduct investigations of complex problems:** Gain ability to design, conduct experiments, analyse and interpret data for investigating problems in Mathematics and allied sectors

PO 5 : **Modern tool usage:** The ability to acquire, develop, employ and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional context, autonomously and collaboratively and across a range of disciplinary

and professional areas.

PO 6 : **The Mathematics Professional and society:** An awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant.

PO 7 : **Environment and sustainability:** Understand complex environmental issues and their interrelationships and requirement of interdisciplinary domains for sustainable development

PO 8 : **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and norms.

PO 9 : **Individual and team work:** Able to function effectively as individual and as a member in multidisciplinary settings.

PO 10 : **Communication:** Communicate effectively using different modes (viz. written, verbal and digital) not only with scientific community but also with the society at large.

PO 11 : **Project management and finance:** Understand the principles of management of finance and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 : **Life-long learning:** Able to recognize the need to undertake life-long learning and acquire the capacity to do so.

PROGRAMME SPECIFIC OUTCOME (PSOs) FOR B. Sc. MATHEMATICSPROGRAMME

After completion of the programme the Graduate will:

PSO 1 : Understand the advanced concepts of mathematics and demonstrate the ability to apply the knowledge of mathematics at an advanced level.

PSO 2 : Collect, organize and adapt contemporary knowledge effectively and utilize appropriate computational tools independently and analyse and perform a broad variety of mathematical experiments using mathematical software and internet.

PSO 3 : Develop and apply new theories of mathematics to solve a broad variety of problems involving mathematics.

PSO 4 : Apply critical thinking skills for the sustainable development and develop the

knowledge and skills to secure employment.

PSO 5 : Exhibit the capacity to identify, formulate, and solve problems pertaining to mathematics through research and critically evaluate the theoretical results and recognize the need for, and an ability to engage in life-long learning.

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot

(An Autonomous College affiliated to Saurashtra University, Rajkot)

Department of Mathematics

B.Sc. Mathematics

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022& onwards

Semester I									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21ULCEN101	Development of Functional English	3	-	-	3	40	60	100	3
	Part-I Total	**3**	**0**	**0**		**40**	**60**	**100**	**3**
Part-II									
21UMTCC101	**Core 1:** Differential Calculus (F)	3	-	-	3	30	70	100	3
21UMTCC102	**Core 2:**Matrix Algebra (F)	3	-	-	3	30	70	100	3
21UMTID101	**IDC 1:** Physics: Electricity & Modern Physics	3	-	-	3	30	70	100	3
21UMTCC103	**Core Practical 1**: Practical on Differential Calculus and Matrix Algebra including mathematical software	-		12#	3	40	60	100	6
21UMTID102	**IDC 1 Practical**: Physics: Electricity & Modern Physics	-		6@	3	40	60	100	3
	Core Enrichment 1: Concept to Practice	-	1	-	-	(20)	Evaluation at the end of semester - 4		
	Part-II Total	**9**	**1**	**18**		**190**	**330**	**500**	**18**

Semester I Continue…									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
		T	**Tu**	**P**					
Part-III: Ability Enhancement Courses									
21AESD101	**AECC I:** Introduction to SDG (online course)	-	-	-	-	Remarks			Audit course
-	**AECC II:** Environmental Conservation and Sustainable Development	1	-	-	-	Evaluation at the end of 2nd Semester			-
-	**AECC III:** Human Values for Holistic Living	1	2*	-	-	Evaluation at the end of 2nd Semester			-
	FS 3: Career Acceleration Program	2*	-	-	-	Cumulative evaluation at the end of Semester V			
	Part-III Total	**2**	**2***	**0**		**0**	**0**	**0**	**0**
	Total (Part-I to Part-III)	**14+2***	**1+2***	**18**		**230**	**390**	**600**	**21**
		33+2*+2*				**600**			

*Out of working Hours.| # 3 hours each on Day 1, 2 3 and 4. | @ 3 hours each on Day 1 and 2

( ) Final evaluation for 100 marks be made at the end of Semester IV which includes 20 marks CIA in Semester I, II, III each and 40 marks in Semester IV.

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022 & onwards

Semester II									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21ULCEN201	Functional English	3	-	-	3	40	60	100	3
	Part-I Total	**3**	**0**	**0**	**3**	**40**	**60**	**100**	**3**
Part-II									
21UMTCC201	**Core 3**:Differential Equations (Ap)	4	-	-	3	30	70	100	4
21UMTCC202	**Core 4:**Advanced Calculus (Ad)	4	-	-	3	30	70	100	4
21UMTID201	**IDC 2:** Physics: Electronics and Radiation Physics	3	-	-	3	30	70	100	3
21UMTCC203	**Core Practical 2**: Practical on Differential equations and Advanced Calculus including mathematical software	-	-	8#	3	40	60	100	4
21UMTID202	**IDC 2 Practical:** Physics Practical: Electronics and Radiation Physics	-	-	6@	3	40	60	100	3
	Core Enrichment 1: Concept to Practice	-	1	-	-	(20)	Evaluation at the end of semester - 4		
	Part-II Total	**11**	**1**	**14**		**190**	**330**	**500**	**18**

Semester II									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
		T	**Tu**	**P**					
Part-III: Ability Enhancement Courses									
21AEES201	**AECC II:** Environmental Conservation and Sustainable Development	1	-	-	-	Remarks			2
21AEVE202	**AECC III:** Human Values for Holistic Living	1	2*	-	-	Remarks			3
	FS 3: Career Acceleration Program	2*	-	-	-	Cumulative evaluation at the end of Semester V			
	Part-III Total	**2+2***	**2***	**0**	**-**	**0**	**0**	**0**	**5**
	Total (Part-I to Part-III)	**16+2***	**1+2***	**14**		**230**	**390**	**600**	**26**
		31+2*+2*				**600**			

*Out of working Hours. | # 2 hours each on Day 1, 2, 3 and 4. | @ 3 hours each on Day 1 and 2

( ) Final evaluation for 100 marks be made at the end of Semester IV which includes 20 marks CIA in Semester I, II, III each and 40 marks in Semester IV.

Minimum one-month internship pertaining to learning for concept to practice/prototype or product development for start-up/mini and final semester project/skilling in the summer vacation/ combination of semester break and summer vacation in industry/premier research institute/NGO, etc.

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022 & onwards

Semester III									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21ULCEN03	Advanced English &Correspondence	3	-	-	3	40	60	100	3
	Part-I Total	**3**	**-**	**-**	**3**	**40**	**60**	**100**	**3**
Part-II		**T**	**Tu**	**P**					
21UMTCC301	**Core 5:** Fundamentals of Mathematical Analysis (F)	3	-	-	3	30	70	100	3
21UMTCC302	**Core 6:** Introduction to Complex Analysis (F)	3	-	-	3	30	70	100	3
21UMTCC303	**Core 7:** Discrete Mathematics (Ad)	3	-	-	3	30	70	100	3
	DSE 1 C1:##	3	-	-	3	30	70	100	3
21UMTCC304	**Core Practical 3: Practical on Computer Aided Mathematics**	-	-	8#	3	40	60	100	4
	DSE 1 Practical 1 :##	-	-	6@	3	40	60	100	2
	Core Enrichment 1: Concept to Practice	-	1	-	-	(20)	Evaluation at the end of semester - 4		
	Core Enrichment 2: Internship 1/ Training Project	-	-	-		100	-	100	1
	Part-II Total	**12**	**1**	**14**		**320**	**400**	**700**	**19**

Semester III									
Course Co	e	Contact Hrs/ week			SEE Duration (Hours)	Maximum Marks			Credits
						CIA	SEE	Total	
		T	Tu	P					
Part-III: A	**cement Courses**								
-	Acceleration m	-	2*	-					Audit course
	Part-III Total		**2***			**0**	**0**	**0**	
	al (Part-I to Part-III)	**15**	**1+ 2***	**14**		**360**	**460**	**800**	**22**
		30+2*				**800**			

2 hou Day 1, 2, 3and 4.

( ) Fina n for 100 marks be made at the end of Semester IV which includes 20 marks mester I, II, III each and 40 marks in Semester IV.

Dis cific Elective-DSE-1 offered by the Department to the Cluster for all B.Sc. I mester – III

Semester III									
Course Co	urse	Contact Hrs/ week			SEE Duration (Hours)	Maximum Marks			Credits
						CIA	SEE	Total	
Part-I		**T**	**Tu**	**P**					
21UMTI	ic hematics	3	-	-	3	30	70	100	3
21UMTI	ctical on Basic hematics	-	-	6	3	40	60	100	2

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022 & onwards

Semester IV									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21ULCEN04	Effective Communicative Skills	3	-	-	3	40	60	100	3
	Part-I Total	**3**	**-**	**-**	**3**	**40**	**60**	**100**	**3**
Part-II		**T**	**Tu**	**P**					
21UMTCC401	**Core 8:**Fundamentals of Linear Algebra (F)	4	-	-	3	30	70	100	4
21UMTCC402	**Core 9:** Integral and Vector Calculus (Ad)	3	-	-	3	30	70	100	3
21UMTDA401 21UMTDA402	**Core Elective 1:** Introduction to Graph Theory / Number Theory	3	-	-	3	30	70	100	3
	DSE 2: C2##	3	-	-	-	30	70	100	3
	TDE 1:	2	-	-		100	-	100	2
21UMTCC404	**Core Practical 4:** Practical on Numerical Methods and Plotting including Mathematical Software	-	-	8#	3	40	60	100	4
	DSE 2 Practical: C2##	-	-	6@	3	40	60	100	2
	Core Enrichment 1: Concept to Practice	-	1	-	-	40	-	100	1
	Part-II Total	**14**	**1**	**14**		**340**	**400**	**800**	**22**
Part-III: Ability Enhancement Courses									
-	**FS III:** Career Acceleration Program	-	2*	-					Audit course
	Part-III Total		**2***			**0**	**0**	**0**	
	Total	**17**	**1+ 2***	**14**		**380**	**460**	**900**	**25**

	(Part-I to Part-III)	**32+2***		**900**	

Minimum one month internship pertaining to learning for concept to practice/prototype or product development for start-up/ mini and final semester project/ skilling in the summer vacation/combination of semester break and summer vacation in industry/ premier research institute/NGO etc.

Discipline specific Elective-DSE -2 offered by the Department to the Cluster for all B.Sc. Program Semester – IV

Semester IV									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21UMTDE401	DSE 2: Mathematics for Scientific Calculation and Analysis	3	-	-	3	30	70	100	3
21UMTDE402	DSE 2 Practical: Practical on Mathematics for Scientific Calculation and Analysis	-	-	6	3	40	60	100	2
21UMTDE403	DSE 2: Advance Mathematics	3	-	-	3	30	70	100	3
21UMTDE404	DSE 2 Practical: Advanced Mathematics Practical	-	-	6	3	40	60	100	2

TDE 1: Trans disciplinary Elective Course offered by the department to other departments for all B.Sc. Program – Sem-4

Semester IV									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**Total**	
Part-I		**T**	**Tu**	**P**					
21UMTTD01	TDE 1: Fundamentals of Statistics	2	-	-	-	100	-	100	2

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022 & onwards

Semester V									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**TOTAL**	
Part-II		**T**	**Tu**	**P**					
21UMTCC501	**Core 10:** Fundaments of Numerical Analysis(Ap).	4	-	-	3	30	70	100	4
21UMTCC502	**Core 11:** Problem solving using programming (Ap)	4	-	-	3	30	70	100	4
21UMTCC503	**Core 12:** Group Theory(F)	4	-	-	3	30	70	100	4
21UMTCC504	**Core 13:** Concept Recapitulation Test (CRT) (F)	-	-	-	3	50/ 100	-	50/ 100	1
21UMTCC505	**Core 14:** Set theory and Logic (Ap) (Self-Study Course) (Ap)	1	-	-	3	30	70	100	4
21UMTCC506	**Core Elective 2:** Advanced Mathematical Analysis (Ad)/ Topology (Ad) / Fuzzy Mathematics(Ad)	3	-	-	3	30	70	100	3
	TDE 2:	2	-	-		100		100	2
21UMTCC507	**Core Practical 5:** Practical on Numerical Analysis and Problem solving using computer programming		-	12#	**3+3**	40	60	100	6
21UMTCC508	**Core Enrichment 3:** Internship /Training	-	-	-		100		100	1

21UMTCC509	**Core Enrichment 4:** Minor Project / Dissertation/ Review Article Writing/ Industrial Visit Report	2	4	-	-	-	Evaluation at the end of semester - 6		
	Part-II Total	**20**	**04**	**12**		**490**	**410**	**900**	**29**
Part-III: Ability Enhancement Courses									
-	**FS III: Career Acceleration Program (CAP)**	-	2*	-		Remarks			Audit course
21AEFS501	**FS IV:** Community Engagement	-	2*	-		Remarks			Audit course
	Part-III Total	**0**	**4+4***	**0**	**-**	**0**	**0**	**0**	
	Total (Part-I to Part-III)	**20**	**4+4***	**12**		**490**	**410**	**900**	**29**
		36+4*				**900**			

2 hours each on day of the week.

SCHEME OF LEARNING AND EVALUATION

For the students admitted from A.Y. 2021-2022 & onwards

Semester VI									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**TOTAL**	
Part-II		**T**	**Tu**	**P**					
21UMTCC509	**Core Enrichment 4:** Minor Project / Dissertation/ Review Article Writing/ Industrial Visit Report	-	-	-	-	100	-	100	4
21UMTCC601	**Core 15:** Complex Analysis(Ap)	4	-	-	3	30	70	100	4
Core Enrichment 5:									
21UMTCC602	**Core 16:** Advanced Topic in Numerical Analysis (Ad)	4	-	-	3	30	70	100	4
21UMTCC603	**Core 17:** Optimization through Mathematical Programming **(**Ap)	4	-	-	3	30	70	100	4
21UMTCC604	**Core Practical 6:** Practical on Advanced Numerical Analysis and Optimization(Ap)	-	-	12#	3+3	40	60	100	6
	Total	**14**	**4**	**12**	**-**	**230**	**270**	**500**	**22**

OR

Semester VI									
Course Code	**Course**	**Contact Hrs/ week**			**SEE Duration (Hours)**	**Maximum Marks**			**Credits**
						CIA	**SEE**	**TOTAL**	
Part-II		**T**	**Tu**	**P**					
21UMTCC509	**Core Enrichment 4:** Minor Project / Dissertation/ Review Article Writing/ Industrial Visit Report	2	4	-	-	100	-	100	4
21UMTCC601	**Core 15:** Complex Analysis(Ap)	4	-	-	3	30	70	100	4
Core Enrichment 5:									

	Project / Skill training / Start-up/	14	4	-	-	120	180	300	14
	Total	**20**	**4**	**-**	**-**	**250**	**250**	**500**	**22**

Formation of Part-III

Course Code	Semester	Course / Component	Contact Hrs	No. of Courses	Credit/ Course	Total Credits
A. Ability Enhancement Course (AEC)						
(i) Ability Enhancement Compulsory Course (AECC)						
	I	**AECC I :** Introduction to SDG (online course)	-	1	Remarks	Audit Course
	I & II	**AECC II:** Environmental Conservation and Sustainable Development	1 Hr / Week / Semester	21UMTCC505	**Core 14:** Concept Recapitulation Test (CRT)	2
	I & II	**AECC III:** Human Values for Holistic Living	1 T + 2 Tu /Week /Semester	1	1+1+1	3
					Sub Total	**5 + Audit course**
(ii) ***Skill Enhancement Course (SEC)***						
As per common list	Any Semester between II –V/VII	**SEC-I** *Value Added Courses	40 Hrs	1	1	1
	Any Semester between III – V/VII	**SEC-II** **Co-Curricular Course	80 to 120 Hrs	1	2	2
					Sub Total	3
B. Finishing School						
		FS I *to* FS IV *Compulsory to Earn Degree.*				
	I	**FS I:** Student Induction Program	3 weeks Phase 1, Phase 2, Phase 3	-	Remark	Audit course
	Across I & II Semesters	**FS II:** Fundamentals of Design Thinking (Online/Offline)	40 to 60 Hrs	1	Remark	Audit course
	Semesters I to V / VII	**FS III:** Career Acceleration	2 Hrs / Week /Semester	As per syllabus	Remarks	Audit course

		Program **(CAP)** (Placement training)				
	Semester V (3 yrs program) Semester VI (4 yrs program)	**FS IV:** Community Engagement	Twice a month	1	Remarks	Audit course
		FS V *to* FS VIII *Options for Advanced Learners*				
	Any semester from II to V/VII	**FS V:** Indian & Foreign Languages	-	Any number of courses	Remarks	Audit course
	Any semester from II to V/VII	**FS VI:** Any number of Online course(s) from select MOOC platforms	-	Any number of courses	Remarks	Credit as per provider/audit course
	Any semester from III to V/VII	**FS VII:** Advanced Design Thinking	-	1	Remarks	Audit course
	Any semester from I to VI/VIII	**FS VIII: #Extra Credit Course** Any number of courses from any UG program across the College.	Self-Study	Any number of courses	As per course offered	As per credit(s) earned across all courses opted
Grand Total			**8+ Audit course+ Extra credit courses**			

***Value Added Courses** - Option to student to choose at least 1 from a list of courses offered by any department across the College.

****Co-Curricular Courses** - Option to students to choose 1 from a list of courses offered by any department across the College.

Student may opt for any course of the odd/even prevailing semester from any UG program across the College with the following guidelines:

a. Attending class not mandatory.
b. May be mentored by the course teacher.
c. Preparation through self-study.
d. CIA not mandatory; evaluated for total marks at the end of the semester.
e. Indicates options to appear for the course through examination application and payment of examination fees of that course.
f. Credits earned through each course indicated in the consolidated mark sheet as extra credits; not included for CGPA, percentage marks and classification.

TOTAL MARKS & CREDIT DISTRIBUTION TO EARN THE DEGREE

S.No	PART	Total Marks	Total Credits
1.	**PART I:** Language Course	400	12
2.	**PART II:** Core, IDC, DSE, TDE	3900	128
3.	**PART III:** AECC-I, II & III SEC- I & II FS I, II, III & IV	Remarks	8+ audit course
	TOTAL	**4300**	**148**

VALUE ADDED COURSES (VAC) COURSES OFFERED BY THE DEPARTMENT

Sr. No.	Course Code	Course Title	Course Duration	Credits
1	21AEVA05	Vedic Mathematics	40	1

CO-CURRICULAR COURSES (CoC) COURSES OFFERED BY THE DEPARTMENT

Sr. No.	Course Code	Course Title	Course Duration	Credits
1.	21AECO09	Quantitative Aptitude & logical reasoning for industrial placement	100 Hrs.	2
2.	21AECO06	Preparation for Gujarat State Competitive Exams	100 Hrs.	2

Enclosure –BMTII

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)

Affiliated to Saurashtra University, Rajkot

Core Course (Theory)		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC501	**Core 10: Fundaments of Numerical Analysis.**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

This course is an introduction to the fundamental techniques of numerical analysis, with a focus on the analysis and solution of mathematical problems using computational methods. The course will cover topics such as empirical laws and curve fitting, theory of equation, simultaneous linear algebraic equations, finite differences, and interpolation with equal intervals.

Course Purpose:

The purpose of the course Fundamentals of Numerical Analysis is to introduce students to the basic principles and techniques of numerical analysis. This course is designed to help students develop a solid foundation in computational methods for solving mathematical problems, and to prepare them for more advanced courses in numerical analysis and related fields.

By the end of the course, students will have a comprehensive understanding of these topics, as well as the ability to apply numerical methods to solve a variety of mathematical problems.

The course is intended for students in undergraduate programs who have a strong background in mathematics and programming. It will provide students with the tools and techniques they need to analyze and solve mathematical problems using numerical methods, and will also help them develop critical thinking and problem-solving skills that are essential in many areas of science, engineering, and technology..

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Recall and describe the empirical laws used in curve fitting, including linear regression, polynomial regression, and exponential regression.	K_1

CO_2	Interpret and explain the concepts of roots, zeros, and solutions of nonlinear equations and their applications.	K_2
CO_3	Apply numerical methods, to find the roots of nonlinear equations.	K_3
CO_4	Analyze the properties and solutions of linear algebraic equations and their applications in problems from different fields	K_4
CO_5	Evaluate the efficiency and accuracy of numerical methods for solving linear algebraic equations, including direct and iterative methods.	K_5
CO_6	Create and implement interpolation algorithms with equal intervals, such as Newton's divided differences and Lagrange's formula, to estimate unknown values of a function at a given point.	K_6

Course Contents	**Hours**
Unit-I: Empirical Laws and Curve Fitting	**10**
● Introduction. ● The Linear Law. ● Laws reducible to linear law ● Principle of Least Squares. ● Fitting a Straight Line. ● Fitting a Parabola. ● Fitting an Exponential Curve. ● Fitting the curve $y = ax^b$.	
Unit-II: Theory of Equation.	**10**
● Introduction. ● Relation between Roots and Coefficients. ● Equation with Real Coefficients and Imaginary Roots. ● Equation with Rational Coefficients and Irrational Roots. ● Symmetric Function of Roots. ● Formation of Equation whose Roots are Given. ● Transformation of Equation. ● Multiple Roots.	
Unit- III: Simultaneous Linear Algebraic Equation.	**10**
● Introduction. ● Gauss elimination method. ● Gauss Jordan method. ● Method of factorization (L.U. Decomposition). ● Crout's method. ● Jacobi's method of iteration	
Unit- IV: Finite Differences.	**10**
● Introduction. ● Finite differences (forward, backward and central).	

• Differences of polynomials. • Factorial polynomial. • Reciprocal Factorial polynomial. • Polynomial factorial notation. • Error propagation in difference table. • Other difference operators (Shift, averaging, differential and) and relation between them.	
Unit- V: Interpolation with Equal Intervals.	**8**
• Introduction. • Gregory- Newton forward interpolation formula. • Gregory- Newton backward interpolation formula. • Equidistance terms with one or more missing values.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

1. Numerical methods by Dr. V. N. Vedamurthy& Dr. N. Ch. S. N. Iyengar, (1998) Vikas Publishing house.
2. Numerical Methods with C++ Programming, (2009), Nita H. Shah, PHI Learning Pvt. Ltd.

REFERENCE BOOKS:-

1. M. K. Jain, S. R. K.Iyengar, R. K. Jain (1996) Numerical method, Problems & Solutions, by, New Age International Pvt. Ltd
2. J. B.Scarforough,(1966) Numerical Mathematical Analysis, Oxford & IBH Publi. Co. Pvt. Ltd.

Suggested reading / E-resources:

- MathWorks: https://www.mathworks.com/
- NIST Digital Library of Mathematical Functions: https://dlmf.nist.gov/
- Wolfram MathWorld: https://mathworld.wolfram.com/
- Numerical Recipes: https://www.nr.com/
- The Netlib Repository: https://www.netlib.org/
- GNU Scientific Library: https://www.gnu.org/software/gsl/
- SciPy: https://www.scipy.org/
- Society for Industrial and Applied Mathematics (SIAM): https://www.siam.org/
- Coursera: https://www.coursera.org/
- Khan Academy: https://www.khanacademy.org/

Suggested MOOCs:

- Introduction to Numerical Analysis - edX: https://www.edx.org/course/introduction-to-numerical-analysis-2
- Introduction to Numerical Methods - NPTEL: https://nptel.ac.in/courses/111/105/111105102/
- Numerical Methods - Swayam: https://swayam.gov.in/nd1_cec18_ma11/preview
- Fundamentals of Numerical Methods - Swayam: https://swayam.gov.in/nd1_noc19_ma03/preview
- Introduction to Numerical Analysis - Udemy: https://www.udemy.com/course/introduction-to-numerical-analysis/
- Numerical Analysis for Applied Mathematics - OpenLearn: https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/mathematics/numerical-analysis-applied-mathematics/content-section-0
- Numerical Analysis for Differential Equations - OpenLearn: https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/mathematics/numerical-analysis-differential-equations/content-section-0

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 50)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC502	**Core 11: Problem solving using programming.**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

We will use the C language for this course of the **Problem solving using programming.** This course provides a comprehensive overview of the C programming language. The course covers the basics of C programming and includes an introduction to programming concepts such as data types, control structures, functions, and arrays.

Throughout the course, students will learn how to write, compile, and debug C programs using a variety of tools, including text editors and integrated development environments (IDEs). They will also learn how to use basic input/output functions.

At the end of the course, students will have a solid understanding of the C programming language and be able to write basic C programs. They will also have the knowledge and skills to continue learning and working with C on their own.

Course Purpose:

The purpose of the course on Problems Solving using Programming is to equip students with the knowledge and skills required to solve complex mathematical problems using the C programming language. The course aims to develop students' problem-solving abilities by teaching them the fundamental concepts and techniques of computer programming.

The course will cover various mathematical problems. Students will learn how to use C programming constructs to develop algorithms for solving these problems. They will also learn how to implement and test these algorithms to ensure their accuracy and efficiency.

By the end of the course, students will have gained a solid understanding of the programming and its applications in solving mathematical problems. They will have developed the skills necessary to solve mathematical problems using computational methods and will be able to apply this knowledge to various including mathematics and science..

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Explain how mathematical problems can be solved using computational methods and C programming techniques.	K_2
CO_2	Write program to solve given mathematical problem using the same	K_2, K_4
CO_3	Find errors in the C program and correct it.	K_3
CO_4	Apply C programming constructs to develop algorithms for solving mathematical problems in different fields, such as science, engineering, and finance.	K_3
CO_5	Evaluate mathematical solutions, compare and contrast different approaches, and determine the most appropriate solution for a given problem.	K_1, K_2, K_3, K_4
CO_6	Evaluate the suitability of different programming constructs and algorithms for solving mathematical problems based on their efficiency, accuracy, and applicability.	K6
CO_7	Create a C program that solves a specific mathematical problem by developing an algorithm, implementing the algorithm, and testing it for accuracy and efficiency.	K6
CO_8	Evaluate mathematical solutions, compare and contrast different approaches, and determine the most appropriate solution for a given problem.	K6

Course Contents	**Hours**
Unit-I: Introduction to C	**10**
● History of C, C character set ● Constants, Variables, Keywords, Type Declaration, Type Conversion ● Hierarchy of operators ● printf & scanf functions ● Simple programs using these basic concepts.	
Unit-II: Decisions and Branching	**10**
● if statement, if-else statements ● Nested if-else, elseif clause ● Logical operators, Conditional operators ● Programs using these concepts	
Unit- III: Looping Mechanism and User Defined Functions	**10**

● While loop, for loop ● do-while loop, break statement ● Continue statement, goto statement ● Brief introduction to User Defined Functions ● Programs using these concepts	
Unit- IV: Data types and Preprocessor	**10**
● Data types in C Integers: long and short types ● signed and unsigned characters, Signed and unsigned ● float and doubles ● C processors, meaning ● Macro Expansion ● Macros with Arguments ● Programs using these concepts	
Unit- V: Unit 5: Introduction to Arrays	**8**
● Arrays, meaning: ● One dimensional and two dimensional ● Declaration and initialization of one dimensional and two dimensional arrays ● Use of one dimensional and two dimensional arrays in simple programs	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Interactive exercises.
- Online resources

TEXT BOOKS: -

1. Yashvant Kanetker, (2016), LET US C, 5th Edition, BPB Publications, New Delhi.
2. E. Balagurusamy, (2017), Programming in ANSI C, McGrew Hill Education, Seventh Edition.

REFERENCE BOOKS: -

1. Brian W. Karnighan and Dennis M. Ritchie, (1988), The ANSI C Programming Language, Prentice Hall.
2. V. Rajaraman, (1994), Computer Programming in C, Prentice Hall of India.

Suggested reading / E-resources:

- Learn-C.org: https://www.learn-c.org/
- Geeks for Geeks: https://www.geeksforgeeks.org/c-programming-language/
- Programiz: https://www.programiz.com/c-programming
- Tutorials point: https://www.tutorialspoint.com/cprogramming/index.htm
- C Programming.com: https://www.cprogramming.com/
- C for beginners: https://www.c-for-beginners.com/
- C Programming Notes: http://www.mathcs.emory.edu/~cheung/Courses/255/Syllabus/1-C-intro/

- Cprogramming.com: https://www.cprogramming.com/tutorial/c/lesson1.html
- Stanford CS Education Library: https://cslibrary.stanford.edu/101/EssentialC.pdf
- C Language Reference: https://en.cppreference.com/w/c/language.

Suggested MOOCs:

- C Programming For Beginners - Udemy: https://www.udemy.com/course/c-programming-for-beginners-/
- C Programming - edX: https://www.edx.org/course/c-programming
- Programming in C - Coursera: https://www.coursera.org/learn/c-programming
- C for Everyone: Programming Fundamentals - Coursera: https://www.coursera.org/learn/c-for-everyone
- C Programming: Getting Started - FutureLearn: https://www.futurelearn.com/courses/c-getting-started
- C Programming For Everyone - Udacity: https://www.udacity.com/course/c-programming-for-everyone--ud197
- C Programming Language Fundamentals - Pluralsight: https://www.pluralsight.com/courses/c-fundamentals-with-visual-studio-2015
- C Language Tutorial - Tutorialspoint: https://www.tutorialspoint.com/cprogramming/index.htm
- C Programming Course - Codecademy: https://www.codecademy.com/learn/learn-c
- C Programming Essentials - LinkedIn Learning: https://www.linkedin.com/learning/c-essential-training-2/essential-language-features?u=2105568

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 50)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz

	● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)

Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC503	**Core 12:** Group Theory(F)	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

The course on Group Theory is designed to provide students in the B.Sc. Mathematics program with a comprehensive understanding of the fundamental concepts and properties of groups. Students will explore the definition and examples of groups, including finite groups and their order. The course covers subgroups, normal subgroups, and the theorems associated with them. The study of permutation groups and cyclic groups will enable students to analyze their structures and classifications. The concept of isomorphism and its properties will be studied, along with group homomorphisms and the first isomorphism theorem. Through lectures, discussions, and problem-solving exercises, students will develop the ability to apply group theory in various mathematical contexts and problem-solving scenarios.

Course Purpose:

The purpose of the course on Group Theory is to equip students in the B.Sc. Mathematics program with a strong foundation in the abstract algebraic structure of groups. By studying groups and their properties, students will develop critical thinking and problem-solving skills essential for further studies in mathematics and related disciplines. The course aims to deepen students' understanding of the fundamental concepts and applications of group theory, which serves as a vital tool in areas such as cryptography, number theory, physics, and computer science. Additionally, the course aims to foster students' ability to analyze and classify different types of groups, enabling them to recognize patterns and structures in diverse mathematical contexts.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Recall and define the fundamental concepts of group theory, including groups, subgroups, normal subgroups, and isomorphisms.	K_1
CO_2	Apply basic group theory techniques and algorithms to solve routine problems and exercises.	K_2
CO_3	Classify and analyze different types of groups, such as permutation groups	K_2

	and cyclic groups, based on their structures and properties.	
CO_4	Compare and contrast different types of groups, such as permutation groups and cyclic groups, to identify their distinct characteristics and properties.	K_3
CO_5	Formulate and justify conjectures related to group theory concepts, and develop logical arguments to support or refute them.	K_4
CO_6	Analyze the structure and properties of groups to classify them based on specific criteria.	K_4
CO_7	Evaluate and apply group theory concepts to solve complex mathematical problems and proofs.	K_5

Course Contents	**Hours**
Unit-I: Introduction to Group	**10**
● Definition and examples of Groups. ● Elementary Properties of Group. ● Finite group, Order of a group, Order of an element.	
Unit-II: Subgroups and Normal Subgroups	**10**
● Definition and example of a subgroup. ● Lagrange's Theorem. ● Definition of Centre of a Group and theorems related to it. ● Definition and example of a Normal subgroup. ● Theorems related to Normal Subgroup.	
Unit- III: Permutation Groups and Cyclic Group	**10**
● Definition and examples of Permutation Groups. ● Transposition and Cycle. ● Properties of Cyclic Group. ● Classification of Subgroup of Cyclic Group.	
Unit- IV: Homomorphism of Groups	**10**
● Definition and Examples ● Properties of Homomorphisms ● Kernal of Homomorphism.	
Unit- V: Isomorphism of Groups	**8**
● Definition and Examples ● Cayley's Theorem ● Properties of Isomorphism. ● Automorphisms and Inner Automorphisms.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS:

3. I.H.Sheth, 2nd edition, (2003) , Abstract Algebra, Prentice/Hall of India Private Limited, New Delhi(Unit- 1 to5)
4. I. N. Herstein, (1975), Topics in Algebra, John Wiley & Sons, New York (Unit- 1 to5)

REFERENCE BOOKS:

3. Thomas W. Judson, (2009), Abstract Algebra Theory and Applications, Stephen F. Austin State University.
4. Marlow Anderson & Todd Fel, (2005), A first course in Abstract Algebra (Rings, Groups & fields), Chrpman & Halilereivy,
5. Fraleigh J.B., (2003), A First Course in Abstract Algebra, Narosa Publishing, New Delhi.
6. Joseph A. Gallian, ForthEdition (2011), Contemporary Abstract Algebra, Narosa Publishing House. (Unit- 1 to5)

Suggested reading / E-resources:

- MathWorld: Group Theory - http://mathworld.wolfram.com/GroupTheory.html
- Abstract Algebra Online: Group Theory - https://www.abstract-algebra.net/group-theory/
- Interactive Mathematics: Group Theory - https://www.intmath.com/group-theory/
- PlanetMath: Group Theory - https://planetmath.org/grouptheory
- Online Math Learning: Group Theory - https://www.onlinemathlearning.com/group-theory.html
- Math Insight: Group Theory - https://mathinsight.org/group_theory_introduction
- Brilliant: Cayley's Theorem - https://brilliant.org/wiki/cayleys-theorem/

Suggested MOOCs:

- Coursera: Introduction to Group Theory by University of Colorado Boulder - https://www.coursera.org/learn/introduction-to-group-theory
- edX: Introduction to Group Theory by University of Texas at Austin - https://www.edx.org/professional-certificate/introduction-to-group-theory
- edX: Abstract Algebra: Groups, Rings, and Fields by University of Notre Dame - https://www.edx.org/course/abstract-algebra-groups-rings-and-fields
- Coursera: The Beauty of Algebra by University of Colorado Boulder - https://www.coursera.org/learn/algebra
- Coursera: Algebra for Cryptography by University of California, San Diego - https://www.coursera.org/learn/algebra-cryptography

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 50)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC505	**Core 14:** Set theory and Logic (Ap) (Self-Study Course) (Ap)	**4 Credits - 1 hrs/wk** **(1 Theory)**

Course Description:

The course on "Set Theory and Logic" is designed to provide students in the B.Sc. Mathematics program with a comprehensive understanding of the fundamental concepts and principles of set theory and mathematical logic. Students will explore the properties and operations of sets, including unions, intersections, and complements, and learn how to apply these concepts in various mathematical contexts. The course also covers formal logic, including propositional and predicate logic, allowing students to develop the skills necessary to construct and analyze logical arguments. Through lectures, discussions, and problem-solving exercises, students will develop a solid foundation in set theory and logic, enabling them to apply these tools in advanced mathematical studies and other disciplines.

Course Purpose:

The purpose of the course on "Set Theory and Logic" is to introduce students in the B.Sc. Mathematics program to the fundamental principles and tools of set theory and mathematical logic. The course aims to develop students' understanding of sets, their properties, and operations, as well as the concepts of relations and functions. Additionally, the course focuses on formal logic, including propositional and predicate logic, to equip students with the ability to construct and analyze logical arguments. By studying set theory and logic, students will develop critical thinking skills, logical reasoning abilities, and a solid foundation for advanced mathematical topics and applications in various disciplines.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Define and explain the basic concepts of set theory, such as sets, subsets, unions, intersections, and complements.	K_1
CO_2	Apply the rules of propositional and predicate logic to construct truth	K_2

	tables and evaluate the validity of logical statements.	
CO_3	Analyze and compare different types of sets, such as finite and infinite sets, countable and uncountable sets, and well-ordered sets.	K_3
CO_4	Evaluate the logical equivalences and implications between propositions using laws and rules of propositional and predicate logic.	K_4
CO_5	Design and construct formal proofs using set theory techniques, such as direct proofs, proof by contradiction, and proof by mathematical induction.	K_5
CO_6	Evaluate and analyze the properties of functions and relations, including injectivity, surjectivity, and bijectivity, using set-theoretic concepts.	K_6

Course Contents	**Hours**
Unit-I: Sets and Basic operations on sets	**3**
● Preliminaries: Basic set theory terminology and notation ● Venn Diagrams ● Classes of sets and power set ● Set operations ● Mathematical Induction ● Real Number System R ● Order and Inequalities, Absolute value, Distance, Intervals ● Bounded sets ● Integers Z, Greatest Common Divisor	
Unit-II: Cardinal and Ordinal numbers	**2**
● Denumerable and Countable sets ● Cardinal Numbers, Ordering of Cardinal Numbers ● Cardinal Arithmetic ● Well Ordered sets ● Ordinal Numbers, Structure of Ordinal Numbers	
Unit- III: Functions and Relations	**3**
● Product set, Relations-introduction ● Composition of relation, Types of relation ● Functions-Introduction ● Composition of functions ● One to one, onto and invertible function ● Mathematical functions- exponential, logarithmic function	
Unit- IV: Special Functions and Algorithms	**2**
● Operations of Collections of sets ● Indexed of Collections of sets ● Sequences, Summation symbol ● Fundamental Products ● Functions and Diagrams	

● Special kinds of functions, Fundamental Factorization ● Choice function ● Algorithms and functions ● Complexity of Algorithms	
Unit- V: Logic and Truth Tables	**2**
● Logic propositions: Truth and falsehood of propositions, ● Tautologies and Contradictions ● Logic operations ● Logical equivalence, Equivalences for negations, Equivalent forms of the implications ● Circuits and Logic	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Interactive exercises.
- Online resources

TEXT BOOKS:

1. Robert R. Stoll (1963), Set Theory and Logic, Dover Publications, New York.
2. Karel Hrbacek and Thomas Jech (1999), Introduction to Set Theory, Marcel Dekker.

REFERENCE BOOKS:

1. Ernest Schimmerling (2011), A Course on Set Theory, Cambridge University Press.
2. Seymour Lipschutz (1988), Set Theory and Related Topics, 2nd edition, Schaum's Outline Series, McGraw Hill

Suggested Reading/E-resources:

- Website: MathWorld - Set Theory - http://mathworld.wolfram.com/SetTheory.html
- Website: Stanford Encyclopedia of Philosophy - Set Theory - https://plato.stanford.edu/entries/set-theory/
- Website: Brilliant - Set Theory Fundamentals - https://brilliant.org/wiki/set-theory-fundamentals/

Suggested MOOCs:

- Coursera: "Introduction to Set Theory" by University of California, San Diego - https://www.coursera.org/learn/intro-to-set-theory
- edX: "Introduction to Mathematical Thinking" by Stanford University - https://www.edx.org/professional-certificate/introduction-to-mathematical-thinking
- Coursera: "Mathematical Thinking in Computer Science" by University of California, San Diego - https://www.coursera.org/learn/what-is-a-proof
- "Introduction to Logic" by Stanford University

URL: https://www.edx.org/professional-certificate/introduction-to-logic

- Coursera: "Logic: Language and Information 1" by University of Melbourne - https://www.coursera.org/learn/logic-language-information-1
- edX: "Introduction to Formal Logic" by University of California, Irvine - https://www.edx.org/course/introduction-to-formal-logic
- Coursera: "Discrete Mathematics" by University of California, San Diego - https://www.coursera.org/learn/discrete-mathematics.

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 50)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC506	**Core Elective 2: Advanced Mathematical Analysis (Ad)**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

The course on **"Advanced Mathematical Analysis"** is designed for B.Sc. (UG) students majoring in Mathematics. This course delves into the fundamental concepts and techniques of metric spaces, providing students with a deeper understanding of analysis. The course content includes the study of metric spaces, closed sets, countable sets, and the Cantor set. It also explores important topics such as compact sets and connected sets, which play a crucial role in mathematical analysis. Through rigorous mathematical reasoning and problem-solving, students will develop advanced analytical skills and gain proficiency in working with metric spaces. This course serves as a solid foundation for further studies in analysis and related fields.

Course Purpose:

The course on **"Advanced Mathematical Analysis"** aims to provide a comprehensive understanding of the key concepts and techniques in metric spaces to B.Sc. (UG) students majoring in Mathematics. The purpose of this course is to equip students with advanced analytical skills and a solid foundation in mathematical analysis. By studying metric spaces, closed sets, countable sets, the Cantor set, compact sets, and connected sets, students will develop a deep appreciation for the intricacies of mathematical analysis. This course fosters the ability to rigorously reason and solve complex problems in the context of metric spaces, preparing students for further studies in advanced mathematics and related disciplines.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Recall and define the key concepts of metric spaces, closed sets, countable sets, Cantor set, compact sets, and connected sets.	K1
CO_2	Identify examples and properties of metric spaces, closed sets, countable sets, Cantor set, compact sets, and connected sets.	K1

Course Outcomes: Upon completion of this course, the learner will be able to		
CO_3	Apply the definitions and properties of open sets, closed sets, limit points, and boundaries to solve problems in metric spaces.	K2
CO_4	Analyze and compare the concepts of open sets, closed sets, and neighborhoods in metric spaces.	K3
CO_5	Evaluate and prove theorems related to compact sets, connected sets, and their properties.	K4
CO_6	Formulate and construct proofs for advanced theorems such as the Heine-Borel Theorem, Bolzano-Weierstrass Theorem, and Nested Interval Theorem.	K5
CO_7	Synthesize and apply the concepts of metric spaces, closed sets, countable sets, Cantor set, compact sets, and connected sets to solve complex mathematical problems and proofs.	K6
CO_8	Evaluate and critique mathematical arguments, identifying strengths and weaknesses in proofs related to metric spaces and their properties.	K6

Course Contents	**Hours**
Unit-I: Metric space	**9**
● Metric Space – definition and problems based on it ● Usual Metric Space and Discrete Metric Space ● Problems based on Discrete Metric Space ● Some important results based on Discrete Metric Space. ● Neighbourhood, Interior point, Open set ● Problems based on Open set and Neighbourhood ● Hausdorff Principle ● Open sets in metric space ● Neighbourhood as an Open set ● Open interval as an open set	
Unit-II: Closed Set	**10**
● Limit point, Closed set, Derived set, Dense set, Nowhere Dense ● Problems based on Closed set, derived set ● Results based on Closed set ● Boundary points of a set and problems based on it ● Results based on closure of a set	
Unit- III: Countable set and Cantor set	**10**
● Fundamentals of one-one function and onto function ● Definition of Similar sets ● Problems based on similarity of sets ● Countable sets and problems based on Countable set	

● Definition of the Cantor set ● Some important properties of the Cantor set ● Representation of Real number or m- based expression	
Unit- IV: Compact set	**10**
● Separated set in a metric space ● Difference between disjoint & Separated set ● Definition and examples of Cover of a set ● Definition and examples of Sub cover, Open cover ● Compact sets ● Some important results of Compact set ● Heine Boral Theorem ● Problems based on these concepts	
Unit- V: Connected set	**9**
● Connected set ● Some important results based on Connected set ● Boltzano weirstrass theorem ● Nested Interval Theorem ● Totally Bounded sets ● Sequential Compactness ● Results based on Sequential Compactness ● Problems based on these concepts.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

1. J. N. Sharma and A. R. Vashishtha, (2017), Mathematical Analysis - I, Krishna Prakashan Mandir, MEERUT(U.P.)

REFERENCE BOOKS:-

1. S. C. Malik & Savita Arora, (2009), Mathematical Analysis, New Age Int. Pvt. Ltd .
2. Shantinarayana, 2003), A first course of Mathematical Analysis, S. Chand & sons.
3. Tom.M.Apostol, (1985), Mathematical Analysis, Narosa Publishing House.
4. R. R. Goldberg, (1970), Methods of Real Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
5. H. L. Royden, (2015), Real Analysis, Prentice Hall of India Pvt Ltd. New Delhi

Suggested reading / E-resources:

- Math Insight - Metric Spaces: https://mathinsight.org/metric_spaces_introduction
- Khan Academy - Metric Spaces and Topology: https://www.khanacademy.org/math/differential-geometry/metric_spaces
- Brilliant - Metric Spaces: https://brilliant.org/wiki/metric-spaces

- Interactive Mathematics - Metric Spaces: https://www.intmath.com/counting-probability-statistics/2-metric-spaces.php
- University of Minnesota - Introduction to Metric Spaces: http://www-users.math.umn.edu/~garrett/m/metric_spaces
- OpenLearn - Metric Spaces:
- https://www.open.edu/openlearn/science-maths-technology/metric-spaces/content-section-0
- MathOnline - Metric Spaces: https://mathonline.wikidot.com/metric-spaces

Suggested MOOCs:

- Coursera - Real Analysis: Measure Theory, Integration, and Hilbert Spaces https://www.coursera.org/learn/real-analysis
- edX - Real Analysis: Foundations and Functions https://www.edx.org/professional-certificate/dartmouthx-real-analysis-foundations-and-functions
- Udemy - Advanced Real Analysis https://www.udemy.com/course/advanced-real-analysis
- MIT OpenCourseWare - Real Analysis https://ocw.mit.edu/courses/mathematics/18-100-real-analysis-fall-2006
- FutureLearn - Advanced Mathematics: Linear Algebra and Analysis https://www.futurelearn.com/courses/advanced-mathematics-linear-algebra-analysis
- NPTEL - Advanced Calculus and Real Analysis https://nptel.ac.in/courses/111/102/111102039
- Khan Academy - Multivariable Calculus https://www.khanacademy.org/math/multivariable-calculus

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**
Assignment	● Notes written by the learner on the different topics in the syllabus.				

	● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC506	**Core Elective 2: Topology(Ad)**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

"Topology" is a course designed for B.Sc. (UG) program students majoring in Mathematics. This course provides a comprehensive introduction to the fundamental concepts of topology. Students will explore the theory of topological spaces, including their properties and various types of topologies. The course covers topics such as the Subspace Topology, Continuity, T1 and T2 spaces, and Regular and Normal spaces. Through lectures, problem-solving exercises, and examples, students will develop a solid understanding of the foundational concepts and techniques in topology. This course serves as a basis for further studies in advanced mathematics and lays the groundwork for exploring the rich field of topology.

Course Purpose:

The purpose of the course "Topology" is to provide B.Sc. (UG) program students majoring in Mathematics with a solid foundation in the fundamental concepts of topology. The course aims to familiarize students with the abstract study of spaces and their properties, focusing on topological spaces, the Subspace Topology, Continuity, T1 and T2 spaces, Regular spaces, and Normal spaces. By the end of the course, students will have developed a deep understanding of the basic principles and techniques of topology, enabling them to analyze and describe the structure of various mathematical spaces. This course prepares students for further advanced studies in topology and related fields, equipping them with the necessary tools to tackle complex mathematical problems and theories.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Identify and define the basic concepts of topology, such as topological spaces and the Subspace Topology.	K1
CO_2	Apply the properties of continuous functions in various topological spaces.	K2
CO_3	Recognize and distinguish between different types of spaces, such as T1 spaces and Hausdorff spaces.	K2
CO_4	Analyze and determine whether a given set satisfies the conditions of a basis for a given topology.	K3

CO_5	Evaluate the continuity of functions and determine if they are continuous or discontinuous in specific topological spaces.	K3
CO_6	Construct examples and counterexamples to illustrate the concepts of regular spaces and normal spaces.	K4
CO_7	Evaluate and apply Urysohn's Lemma and Tietze extension theorem to prove results in the context of topology. (K5)	K5
CO_8	Synthesize and create proofs for theorems related to the properties of topological spaces, such as T1 and T2 spaces.	K6

Course Contents	**Hours**
Unit-I: Topological spaces	**9**
● Topological spaces ● Basis for a Topology	
Unit-II: The Subspace Topology	**10**
● The Subspace Topology ● Order Topology	
Unit- III: Continuity	**10**
● Continuous functions ● Metric Topology	
Unit- IV: T_1 and T_2 spaces	**10**
● T_1- spaces ● Hausdorff spaces	
Unit- V: Regular and Normal Spaces	**9**
● Regular spaces and Normal spaces ● Urysohn's Lemma and Tietze extension theorem.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

2. Munkres J., Topology: A first course, Prentice-Hall of India Pvt. Ltd, New Delhi.

REFERENCE BOOKS:-

6. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw Hill Company, Tokyo.
7. Willards S., General Topology, Addition-Wesley, Reading, 1970.

Suggested reading / E-resources:

- Topology Atlas - http://at.yorku.ca/topology/
- Interactive Topology by Jyväskylä University - http://www.bloomtopology.org/

- Wolfram MathWorld: Topology - http://mathworld.wolfram.com/topics/Topology.html
- Brilliant: Topology Fundamentals - https://brilliant.org/wiki/topology-fundamentals/
- Khan Academy: Introduction to Topology - https://www.khanacademy.org/math/differential-geometry/introduction-to-topology
- OpenLearn: Introduction to Topology - https://www.open.edu/openlearn/science-maths-technology/introduction-topology/content-section-0
- MIT OpenCourseWare: Introduction to Topology - https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/
- These websites provide a variety of resources, including interactive materials, tutorials, articles, and course materials, to help students learn and explore the concepts of topology.

Suggested MOOCs:

- Coursera: Introduction to Topology - https://www.coursera.org/learn/introduction-to-topology
- edX: Introduction to Topology - https://www.edx.org/course/introduction-to-topology
- Udemy: Topology Course - Introduction to Topology - https://www.udemy.com/course/topology-course/
- MIT OpenCourseWare: Introduction to Topology - https://ocw.mit.edu/courses/mathematics/18-901-introduction-to-topology-fall-2004/
- FutureLearn: An Introduction to Topology - https://www.futurelearn.com/courses/introduction-to-topology
- Udacity: Intro to Topology - https://www.udacity.com/course/intro-to-topology--st101
- Saylor Academy: MA211: Introduction to Topology - https://learn.saylor.org/course/ma211

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**
Assignment	● Notes written by the learner on the different topics in the				

	syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC506	**Core Elective 2: Fuzzy Mathematics**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:
The course "Introduction to Fuzzy Mathematics" provides students with a comprehensive understanding of the principles and applications of fuzzy mathematics. Fuzzy mathematics deals with handling uncertainty and imprecision in mathematical models and decision-making processes. The course covers the theoretical foundations of fuzzy sets, fuzzy logic, and fuzzy reasoning, along with practical applications in diverse fields. Students will learn to analyze and solve problems using fuzzy sets, explore fuzzy logic systems, and gain insights into fuzzy optimization and decision-making techniques. This course equips students with the necessary knowledge and skills to effectively apply fuzzy mathematics in real-world scenarios, enhancing their problem-solving abilities and mathematical reasoning.

Course Purpose:
The course "Introduction to Fuzzy Mathematics" aims to provide students with a solid foundation in the theory and applications of fuzzy mathematics. The purpose of this course is to familiarize students with the concepts and principles of fuzzy sets, fuzzy logic, and fuzzy reasoning, and their relevance in handling uncertainty and imprecision in mathematical models and decision-making processes. By the end of the course, students will be able to understand and apply fuzzy mathematics to solve complex problems, analyze data with uncertainty, and make informed decisions in various domains. This course also aims to enhance students' critical thinking, problem-solving, and analytical skills, preparing them for advanced studies or professional careers in mathematics or related fields.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Define the concept of a fuzzy set and identify its key components.	K1
CO_2	Recognize and classify fuzzy relations based on their properties.	K2
CO_3	Apply basic operations on fuzzy sets, such as union, intersection, and complement.	K2

CO_4	Evaluate the degree of membership of an element in a given fuzzy set using appropriate membership functions.	K3
CO_5	Analyze and interpret fuzzy relations using composition and aggregation operations.	K3
CO_6	Develop fuzzy rule-based systems to model complex real-world problems and make decisions under uncertainty.	K4
CO_7	Critically analyze and compare different defuzzification methods for obtaining crisp outputs from fuzzy sets.	K4
CO_8	Evaluate the applicability and limitations of fuzzy mathematics in various domains, such as control systems, pattern recognition, and decision analysis.	K5

Course Contents	**Hours**
Unit-I: Introduction to Fuzzy Sets	**9**
● Introduction to fuzzy sets ● Membership functions and membership grades ● Operations on fuzzy sets ● Fuzzy relations and composition ● Fuzzy set-based reasoning	
Unit-II: Fuzzy Logic	**10**
● Fuzzy logic and truth values ● Fuzzy propositions and connectives ● Fuzzy implications and inference rules ● Fuzzy rule-based systems ● Fuzzy control systems	
Unit- III: Fuzzy Mathematics and Applications	**10**
● Fuzzy numbers and arithmetic operations ● Fuzzy relations and their properties ● Fuzzy optimization ● Fuzzy decision-making ● Fuzzy clustering	
Unit- IV: Fuzzy Systems and Approximation	**10**
● Fuzzy systems and their components ● Fuzzy modeling and identification ● Fuzzy rule interpolation and extrapolation ● Approximation using fuzzy sets ● Fuzzy regression analysis	
Unit- V: Advanced Topics in Fuzzy Mathematics	**9**
● . Fuzzy measures and integrals ● Fuzzy graph theory ● Fuzzy neural networks ● Fuzzy time series analysis ● Fuzzy image processing	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

1. "Fuzzy Sets and Fuzzy Logic: Theory and Applications" by George J. Klir and Bo Yuan
2. "Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems" by Guanrong Chen and Trung Tat Pham

REFERENCE BOOKS:-

1. "Fuzzy Mathematics: An Introduction for Engineers and Scientists" by John N. Mordeson and Premchand S. Nair
2. "Fuzzy Logic with Engineering Applications" by Timothy J. Ross
3. "Fuzzy Sets, Uncertainty and Information" by George J. Klir and Bo Yuan

Suggested reading / E-resources:

- Fuzzy Sets and Systems Journal - https://www.journals.elsevier.com/fuzzy-sets-and-systems
- Fuzzy Math - http://www.fuzzymath.com]
- Fuzzy Logic Toolbox Documentation - https://www.mathworks.com/help/fuzzy
- Fuzzy Systems and Fuzzy Logic - https://www.tutorialspoint.com/fuzzy_systems/index.htm
- Fuzzy Logic Tutorial - http://www.fuzzy-logic.com
- Fuzzy Logic Control - https://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol2/cs11/report.html
- Fuzzy Mathematics - https://sites.google.com/a/umn.edu/fuzzy-mathematics

Suggested MOOCs:

- "Introduction to Fuzzy Logic and Fuzzy Sets" - Udemy https://www.udemy.com/course/introduction-to-fuzzy-logic-and-fuzzy-sets/
- "Fuzzy Logic and Fuzzy Sets: Theory and Applications" - edX https://www.edx.org/course/fuzzy-logic-and-fuzzy-sets-theory-and-applications
- "Introduction to Fuzzy Sets and Fuzzy Logic" - Coursera https://www.coursera.org/learn/fuzzy-sets-fuzzy-logic
- "Fuzzy Logic for Beginners" - Udemy https://www.udemy.com/course/fuzzy-logic-for-beginners/
- "Fuzzy Systems and Control" - Coursera https://www.coursera.org/learn/fuzzy-systems-control
- "Applied Fuzzy Logic for Decision Making" - FutureLearn https://www.futurelearn.com/courses/applied-fuzzy-logic

- "Fuzzy Logic with Engineering Applications" - Udemy
  https://www.udemy.com/course/fuzzy-logic-with-engineering-applications/

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Practical) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTCC507	**Core Practical 5:** **Practical on Numerical Analysis and Problem solving using computer programming**	**6 Credits- 12 hrs/wk**

Course Description:

The course "Practical on Numerical Analysis and Problem Solving using Computer Programming" is designed for undergraduate students in mathematics who want to learn how to apply numerical methods to solve mathematical problems and to learn computer programming. In this course, students will learn the fundamental numerical techniques and algorithms required to solve problems that are difficult or impossible to solve analytically. The course is structured to provide students with hands-on experience in solving problems using computer programming.

This course introduces students to the fundamentals of the C programming language and its applications in problem-solving. Topics covered include C language basics, operators, decision-making and branching, looping mechanisms, user-defined functions, data types, preprocessor directives, introduction to arrays, and practical implementation of these concepts through a series of programming exercises. By the end of the course, students will gain proficiency in using C language constructs to solve mathematical problems efficiently.

Course Purpose:

The purpose of the course of Practical on Numerical Analysis for a UG program in Mathematics is to provide students with a comprehensive understanding of numerical methods and their applications in solving mathematical problems. Through this course, students will learn to analyze and solve mathematical problems numerically, gain proficiency in various numerical methods, such as interpolation, numerical integration, and numerical solution of differential equations, The purpose of the course of Problem Solving using Computer Programming is to equip students with the skills and tools necessary to solve mathematical problems using a computer program. Through this course, students will learn the basics of programming, gain proficiency in a high-level programming language such as C language develop the ability to apply programming techniques to solve mathematical problems. Additionally, students will learn how to write efficient and well-structured programs. The course will also help students develop critical thinking and problem-solving skills, which are essential in mathematics and other STEM fields..

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Develop proficiency in implementing numerical algorithms to solve mathematical problems using computer programming.	K3
CO_2	Analyze and select appropriate numerical methods for solving mathematical problems	K4
CO_3	Evaluate the accuracy and efficiency of numerical methods for solving mathematical problems and identify their limitations.	K5
CO_4	Apply knowledge of numerical methods to solve practical mathematical problems.	K3, K4
CO_5	Apply problem-solving strategies to analyze and solve mathematical problems using computer programming.	K3, K4
CO_6	Create algorithms to solve mathematical problems using computer programming.	K5
CO_7	Evaluate and choose appropriate numerical methods to solve mathematical problems.	K6
CO_8	Analyze and optimize programs to solve mathematical problems efficiently.	K4, K6
CO_9	Evaluate the accuracy of numerical methods and analyze the impact of errors on solutions.	K6
CO_{10}	Communicate mathematical ideas and solutions effectively using computer programming.	K6

List of Practical		
Sr.	**Experiments**	**Hrs**
1	(i) Gauss elimination method. (ii) Gauss Jordan method.	**8**
2	LU decomposition method.	4
3	Crout's method.	4
4	(i) Jacobi's method. (ii) Gauss Seidel method.	8
5	(i) Fitting a Straight line. (ii) Fitting an exponential curve $y = e^{ax}$.	8
6	(i) Fitting a Parabola.	8

	(ii) Fitting the curve of the type $y = ax^b$.	
7	Finite differences.	4
8	Gregory- Newton forward interpolation formula.	4
9	Gregory- Newton backward interpolation formula	4
10	Equidistance terms with one or more missing values	4
11	(i) Write a program to find area of a circle when radius is given. (ii) Write a program to calculate the area of a triangle when base and height of the triangle are given. (iii) Write a program to find value of one number raised to another number.	8
12	(i) Write a program to determine whether given number is an even or odd number. (ii) Write a program to find largest of three given numbers. (iii) Write a program to find largest of four given numbers.	8
13	(i) Write program to find net salary when basic salary and other required details are given. (ii) Write a program to solve the quadratic equation	8
14	(i) Write a program to reverse an integer with FIVE digits. (ii) Write a program to verify a number whether it is palindrome or not. (iii) Write a program to find sum of the digits an integer with FIVE digits. (iv) Write a program to print Armstrong numbers between1 to 999.	12
15	(i) Write a program to generate arithmetic and geometric progressions. (ii) Write a program to find nPr and nCr for given value of +ve integers n and r.	8
16	(i) Write a program to find compound interest for given years. (ii) Write a program to find number of odd number and even numbers.	8
17	(i) Write a program to solve the equation by N-R method. (ii) Write a program to find factorial of a given number.	8
18	(i) Write a program using UDF with two arguments and a return value. (ii) Write a program that utilizes a UDF two find prime numbers between two integers entered through key-board.	8
19	(i) Write a program to find value determinant of a 2X2 and a 3X3 matrix. (ii) Write a program to find inverse of a 2X2 matrix.	8
20	(i) Write a program to find diagonal of a 3X3 matrix entered through key-board. (ii) Write a program to find the sum, deference, and multiplication of two 3X3 matrices entered through key-board.	8

Pedagogic Tools:

- Chalk and Board
- Power point presentation
- Handouts
- Computer
- Video

Text books:

M. K. Jain, S.R.K. Iyengar and R.K. Jain, (2022), Numerical Methods, 8th Edition, New Age International Publishers, New Delhi.

- Numerical Methods with C++ Programming, (2009), Nita H. Shah, PHI Learning Pvt. Ltd.
- Yashvant Kanetker, (2016), LET US C, 5th Edition, BPB Publications, New Delhi.
- E. Balagurusamy, (2017), Programming in ANSI C, McGrew Hill Education, Seventh Edition.

Reference books:

- S. D. Conte and Carl De Boor, (2018), Elementary Numerical Analysis, 3rd Edition, McGraw-Hill, New York.
- S.S. Sastry, (2012), Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning Private Limited, New Delhi.
- Brian W. Karnighan and Dennis M. Ritchie, (1988), The ANSI C Programming Language, Prentice Hall.
- V. Rajaraman, (1994), Computer Programming in C, Prentice Hall of India.

Suggested reading / E-resources:

- NIST Digital Library of Mathematical Functions: https://dlmf.nist.gov/
- Wolfram MathWorld: https://mathworld.wolfram.com/
- Numerical Recipes: https://www.nr.com/
- The Netlib Repository: https://www.netlib.org/
- Coursera: https://www.coursera.org/
- Khan Academy: https://www.khanacademy.org/
- Learn-C.org: https://www.learn-c.org/
- Programiz: https://www.programiz.com/c-programming
- Tutorials point: https://www.tutorialspoint.com/cprogramming/index.htm
- C Programming.com: https://www.cprogramming.com/
- C for beginners: https://www.c-for-beginners.com/

Suggested MOOCs:

- Numerical Methods: https://www.edx.org/course/numerical-methods
- Introduction to Numerical Methods: https://www.futurelearn.com/courses/numerical-methods-introduction
- edX: C Programming: Getting Started –

URL: https://www.edx.org/course/c-programming-getting-started

- Coursera: Introduction to Programming in C Specialization –
  URL: https://www.coursera.org/specializations/c-programming
- Udemy: C Programming for Beginners –
  URL: https://www.udemy.com/course/c-programming-for-beginners-/
- Codecademy: Learn C - URL: https://www.codecademy.com/learn/learn-c

Methods of Assessment & Tools:

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1-10 Experiments	$1\frac{1}{2}$ hours	15	30
	Test 2	11-20 Experiments	$1\frac{1}{2}$ hours	15	
B	Attendance and Regularity			5	10
C	Class Activities			5	
				Grand Total	**40**
Class activity	● Quiz ● Situation based question ● Handbook				

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC601	**Core 15:** Complex Analysis(Ap)	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

The course on "Complex Analysis" in the B.Sc. (UG) program majoring in Mathematics provides students with a comprehensive understanding of functions of complex variables and their properties. Students will explore topics such as analytic functions, harmonic functions, and entire functions. The course covers complex integration, including the Cauchy-Riemann conditions, Cauchy's integral formula, and the fundamental theorem of algebra. Students will learn about mapping and power series, including the expansion of complex functions in Taylor's and Laurent's series. The course also introduces singular points, residues, and poles of complex functions, and applies the residue theorem to evaluate improper real integrals. Through lectures, examples, and problem-solving exercises, students will develop a strong foundation in complex analysis, enabling them to apply these concepts in advanced mathematical studies and other related disciplines.

Course Purpose:

The purpose of the "Complex Analysis" course in the B.Sc. (UG) program majoring in Mathematics is to provide students with a deep understanding of complex variables and their functions. The course aims to develop students' knowledge and skills in analyzing and manipulating complex functions. Students will learn about the properties of analytic functions, including limits, continuity, differentiability, and harmonic functions. The course also focuses on complex integration, covering topics such as the Cauchy-Riemann conditions, Cauchy's integral formula, and the fundamental theorem of algebra. Additionally, the course aims to enhance students' problem-solving abilities through the study of mappings, power series, residues, and poles. By the end of the course, students will have a solid foundation in complex analysis, enabling them to apply these concepts to further studies in mathematics and related fields.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Recall and define the concepts of analytic functions, harmonic functions, entire functions, and their properties.	K_1

CO_2	Apply the Cauchy-Riemann conditions in Cartesian and polar forms to determine the differentiability of complex function.	K_2
CO_3	Memorize and identify the fundamental theorems of algebra, including Cauchy's integral formula and the maximum modulus theorem.	K_1
CO_4	Analyze and explain the significance of contour integration and its applications in complex analysis, including the evaluation of definite integrals.	K_3
CO_5	Compare and contrast different types of mappings, such as Mobius mapping, linear functions, and bilinear mapping, and discuss their properties.	K_4
CO_6	Evaluate and apply theorems and techniques, such as the residue theorem and expansion of complex functions in Taylor's and Laurent's series, to solve complex analysis problems.	K_5
CO_7	Create and construct arguments to prove results, such as Cauchy's inequality, Liouville's theorem, and Morera's theorem, related to analytic functions and their properties	K_6
CO_8	Synthesize and integrate knowledge from complex analysis to solve complex problems, including the evaluation of improper real integrals using the residue theorem.	K_6

Course Contents	**Hours**
Unit-I: Analytic Functions	**9**
● Introduction to functions of complex variables ● Limit, continuity and differentiability of complex functions ● Harmonic functions ● Entire functions ● Analytic functions	
Unit-II: : Complex integration	**10**
● C-R conditions in Cartesian form ● C-R conditions in polar form ● Definite integrals ● Contours ● Statement of Cauchy-Goursat theorem and examples ● Cauchy’s integral formula	
Unit- III: Fundamental theorem of Algebra	**10**
● Higher order derivative of analytic function ● Morera’s theorem ● Cauchy’s inequality ● Liouville’s theorem ● Fundamental theorem of algebra ● Maximum modulus theorem	

Unit- IV: Mapping and Power series	10
● Elementary functions ● Mapping by elementary functions ● Mobius mapping ● Linear function ● Bilinear mapping ● Discussion on different types of mapping ● Complex sequence ● Complex series and power series ● Expansion of a complex function in Taylor's series and Laurent's series	
Unit- V: Residues and Poles	**9**
● Introduction to singular points ● Isolated singular points ● Zeros of complex functions ● Poles and residues of complex function ● Cauchy's residue theorem ● Evaluation of improper real integrals by residue theorem ● Evaluation of definite integral of trigonometric functions by residue theorem	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

1. R. V. Churchill and J. W. Brown (2003), Complex variables and applications, 7th Edition, McGraw-Hill.

REFERENCE BOOKS:-

1 J. M. Howie (2004), Complex Analysis, Springer-Verlag.
2 M. J. Ablowitz and A. S. Fokas (1998), Complex Variables-Introduction and Applications, (Indian edition) Cambridge University Press.

Suggested reading / E-resources:

- Math Insight URL: https://mathinsight.org/
- Khan Academy URL: https://www.khanacademy.org/
- Wolfram MathWorld URL: http://mathworld.wolfram.com/
- MIT OpenCourseWare URL: https://ocw.mit.edu/
- Math Stack Exchange URL: https://math.stackexchange.com/
- Complex Analysis by Dr. T.E. Venkata Balaji
  URL: https://www.nptel.ac.in/courses/111/106/111106100/
- Complex Analysis Resources by Dr. S. Arumugam
  URL: https://www.cmi.ac.in/~arumugam/courses/ca2020/

Suggested MOOCs:

- "Complex Analysis" by Coursera
  URL: https://www.coursera.org/learn/complex-analysis
- "Introduction to Complex Analysis" by edX
  URL: https://www.edx.org/course/introduction-to-complex-analysis
- "Complex Analysis" by NPTEL
  URL: https://onlinecourses.nptel.ac.in/noc21_ma12
- "Complex Analysis" by Swayam
  URL: https://swayam.gov.in/nd2_aic20_ma08/
- "Analytic Combinatorics: Complex Analysis for Discrete Structures" by Coursera
  URL: https://www.coursera.org/learn/analytic-combinatorics
- "Complex Analysis with Physical Applications" by edX
  URL:https://www.edx.org/professional-certificate/harvardx-complex-analysis-with-physical-applications

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC602	**Core Practical 16:** Advanced Topics in Numerical Analysis(Ad)	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:
This course is designed to provide students with advanced knowledge and techniques in numerical analysis. The course will cover advanced topics in numerical differentiation, numerical integration, numerical solution of ordinary differential equations, interpolation with unequal intervals, and central difference interpolation formulae. Students will be introduced to theoretical concepts and their practical applications. The course will focus on developing problem-solving skills and analytical thinking.

Course Purpose:
The purpose of the course on Advanced Numerical Analysis for an undergraduate program in Mathematics is to equip students with advanced knowledge and skills in numerical methods and their applications. The course aims to provide students with a deeper understanding of numerical algorithms for solving various mathematical problems, such as interpolation, numerical differentiation, integration, and the numerical solution of ordinary differential equations. Through this course, students will be able to apply numerical analysis techniques to solve problems in various areas. The course also aims to develop students' critical thinking, problem-solving, and programming skills by providing practical applications of numerical methods..

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Demonstrate an understanding of interpolation formulae, including Gauss's forward and backward interpolation formulae, Sterling's formula, Bessel's formula, and Laplace-Everett's interpolation formula, and apply these formulae to interpolate data using central difference methods	K_2, K_3

CO_2	Analyze and solve interpolation problems with unequal intervals using divided differences, properties of divided differences, Newton's divided difference formula, Lagrange's interpolation formula, and Lagrange's inverse interpolation formul	K_2, K_3
CO_3	Apply numerical differentiation methods, including Gregory-Newton's forward and backward difference formulae, Sterling's formula, and central difference methods, to estimate derivatives of functions at given points.	K_2, K_3
CO_4	Apply numerical integration techniques, including the trapezoidal rule and Simpson's rule, to estimate integrals of functions over given intervals.	K_2, K_3
CO_5	Analyze and solve ordinary differential equations using Taylor's series method, Picard's method, Euler's method, Runge's method, and Runge-Kutta methods of various orders.	K_2, K_3
CO_6	Evaluate the accuracy and efficiency of numerical methods for interpolation, differentiation, integration, and solving ordinary differential equations, and justify the appropriateness of the methods for specific problems.	K_4, K_5

Course Contents	**Hours**
Unit-I: Unit 1: Central difference interpolation formulae.	**9**
● Introduction. ● Gauss's forward interpolation formula. ● Gauss's backward interpolation formula. ● Sterling's formula. ● Bessel's formula. ● Laplace- Everett's interpolation formula.	
Unit-II: Interpolation with unequal intervals.	**10**
● Introduction. ● Divided differences. ● Properties of divided difference. ● Relation between divided differences and forward difference. ● Newton's divided difference formula. ● Lagrange's interpolation formula. ● Inverse interpolation. ● Lagrange's inverse interpolation formula.	
Unit- III: Numerical Differentiation.	**10**
● Introduction. ● Numerical Differentiation. ● Derivatives using Gregory-Newton's forward difference formula. ● Derivatives using Gregory-Newton's backward difference formula. ● Derivative using Sterling's formula.	
Unit- IV: Numerical Integration.	**10**

• Introduction. • Numerical Integration. • General quadrature formula. • Trapezoidal rule. • Simpson‘s 1/3 rule. • Simpson’s 3/8 rule.	
Unit- V: Numerical solution of ordinary differential equations.	**9**
• Introduction. • Solution by Taylor’s series method. • Picard’s method. • Euler’s method. • Runge’s method • Runge-Kutta methods and its higher order.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

1. Numerical Methods by Dr. V. N. Vedamurthy & Dr. N. Ch. S. N. Iyengar, (1998) Vikas Publishing house.
2. Numerical Methods with C++ Programming, (2009), Nita H. Shah, PHI Learning Pvt. Ltd.

REFERENCE BOOKS:-

1. M. K. Jain, S. R. K.Iyengar, R. K. Jain (1996) Numerical method, Problems & Solutions, by, New Age International Pvt. Ltd
2. J. B.Scarforough,(1966) Numerical Mathematical Analysis, Oxford & IBH Publi. Co. Pvt. Ltd.

Suggested reading / E-resources:

- MathWorks: https://www.mathworks.com/
- NIST Digital Library of Mathematical Functions: https://dlmf.nist.gov/
- Wolfram MathWorld: https://mathworld.wolfram.com/
- Numerical Recipes: https://www.nr.com/
- The Netlib Repository: https://www.netlib.org/
- GNU Scientific Library: https://www.gnu.org/software/gsl/
- SciPy: https://www.scipy.org/
- Society for Industrial and Applied Mathematics (SIAM): https://www.siam.org/
- Coursera: https://www.coursera.org/
- Khan Academy: https://www.khanacademy.org/

Suggested MOOCs:

- Introduction to Numerical Analysis - edX: https://www.edx.org/course/introduction-to-numerical-analysis-2
- Introduction to Numerical Methods - NPTEL: https://nptel.ac.in/courses/111/105/111105102/
- Numerical Methods - Swayam: https://swayam.gov.in/nd1_cec18_ma11/preview
- Fundamentals of Numerical Methods - Swayam: https://swayam.gov.in/nd1_noc19_ma03/preview
- Introduction to Numerical Analysis - Udemy: https://www.udemy.com/course/introduction-to-numerical-analysis/
- Numerical Analysis for Applied Mathematics - OpenLearn: https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/mathematics/numerical-analysis-applied-mathematics/content-section-0
- Numerical Analysis for Differential Equations - OpenLearn: https://www.open.edu/openlearn/science-maths-technology/mathematics-statistics/mathematics/numerical-analysis-differential-equations/content-section-0

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Theory) For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC603	**Core 17: Optimization through Mathematical Programming.**	**4 Credits - 4 hrs/wk (4 Theory)**

Course Description:

The course "**Optimization through Mathematical Programming**" is designed for undergraduate students and introduces them to the principles and techniques of optimization. The course covers topics such as Introduction to Operations Research, Linear Programming Problems, Duality in LPP and Game Theory, Transportation Problems, Assignment problems and Sequencing Problems. Students will learn to formulate optimization problems in various real-life applications and apply optimization techniques to solve them. The course emphasizes the use of mathematical models to solve complex optimization problems. Throughout the course, students will develop problem-solving skills, critical thinking abilities, and an understanding of the fundamental concepts and principles of optimization.

Course Purpose:

The purpose of the course "**Optimization through Mathematical Programming**" in a UG program is to provide students with an understanding of the theoretical and practical aspects of optimization techniques used in Operations Research. The course aims to equip students with the necessary knowledge and skills to formulate and solve linear programming problems, transportation problems, assignment problems, and sequencing problems. Students will learn how to interpret and analyze optimization results and make informed decisions based on them. Additionally, the course aims to introduce students to the concepts of duality in linear programming and game theory. Overall, the purpose of the course is to enable students to apply optimization techniques to real-world problems and to prepare them for further study in related fields.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**

CO_1	Recall and explain the fundamental concepts of Operations Research.	K_1
CO_2	Evaluate the feasibility and optimality of linear programming problems using graphical method and simplex method.	K_4, K_6
CO_3	Evaluate the optimal solution to transportation problems using various methods like Vogel's approximation method and MODI method.	K_4, K_6
CO_4	Analyze the properties of the assignment problem and formulate it using the Hungarian method.	K_4, K_6
CO_5	Analyze and solve sequencing problems using various methods like Johnson's rule and Branch and Bound method.	K_4, K_6
CO_6	Synthesize and present the solutions to optimization problems using appropriate mathematical and computational tools.	K_6

Course Contents	**Hours**
Unit-I: Introduction to Operations Research	**9**
● Basic of Operations Research. ● History and development of Operations Research ● Applications and scope of Operations Research ● The linear programming problems ● Formulation of LPP ● Matrix form of the LPP ● General form, Canonical form ● Standard form of the LPP ● Graphical method to solve LPP ● Some definitions and basic properties of convex sets ● Convex functions and concave function	
Unit-II: Unit 2:Linear Programming	**10**
● Basic definitions to use Simplex method ● Simplex method (algorithm) to solve LPP ● Big-M method (Penalty method) to solve LPP ● Two phase method to solve LPP ● Problems of LPP based on these methods	
Unit- III: Duality in LPP and Game Theory	**10**
● Principle of duality in LPP ● Primal LPP and method to find its dual LPP ● Simple problems of duality. ● Introduction to Game Theory ● Two-person zero-sum game ● Minimax and maximin principles ● Saddle point of a game ● Games without a saddle point	

● Solution of games by dominance rule. ● Iterative method to solve a game.	
Unit- IV: Transportation Problems	**10**
● The Transportation Problems ● Mathematical and matrix form of TP. ● Initial solution of TP by NWCM, LCM and VAM ● Optimum solution of TP by MODI method (u-v method) (except degenerate solution), ● Balanced and unbalanced TP (Simple problem)	
Unit- V: Assignment problems and Sequencing Problems	**9**
● Mathematical and matrix form of Assignment Problem ● Hungarian method to solve Assignment Problem ● Problems of Assignment and its solution based on this method. ● Introduction to Sequencing Problems ● Terminology Notations and Assumptions ● Processing n-jobs through two machines ● Processing n-jobs through three machines.	

Pedagogic Tools:

- Chalk and board
- Power point presentation
- Seminars
- Online resources

Text Books:

1. J. K. Sharma, (2006), Operations Research (theory and Applications), MacMillan Publishing House .
2. Nita H. Shah, Gor, Ravi M. Soni, Hardik Shah, (2010), Operations Research, PHI Learning.

Reference Books:

- R. K. Gupta, (2018), Operations Research, Krishna Prakashan Mandir, Meeut.
- Hamdy A. Taha,(2013) Operations Research: An Introduction, Pearson Education India,

Suggested reading / E-resources:

- OR-Tools: https://developers.google.com/optimization
- OptaPlanner: https://www.optaplanner.org/
- Coin-OR: https://www.coin-or.org/
- AIMMS: https://www.aimms.com/english/
- GLPK: https://www.gnu.org/software/glpk/
- OpenSolver: https://opensolver.org/

Suggested MOOCs:

- "Linear Optimization" on Coursera: https://www.coursera.org/learn/linear-optimization
- "Introduction to Linear Optimization" by The Hong Kong University of Science and Technology on edX: https://www.edx.org/course/introduction-to-linear-optimization
- "Discrete Optimization" by The University of Melbourne on Coursera: https://www.coursera.org/learn/discrete-optimization
- "Introduction to Operations Research" by RWTH Aachen University on edX: https://www.edx.org/course/introduction-to-operations-research.

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 50)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Core Course (Practical)		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **B.Sc. Mathematics**	
Semester – VI		
Course Code	Course Title	Course Credit and Hours
21UMTCC604	**Core Practical 6:** Practical on Advanced Numerical Analysis and Optimization (Ap)**.**	**6 Credits - 12 hrs/wk**

Course Description:

Practical on **Advanced Numerical Analysis and Optimization** is a course designed for undergraduate students majoring in Mathematics. This course provides a comprehensive understanding of advanced topics in numerical analysis and optimization. The course introduces students to advanced numerical techniques and optimization algorithms. The course covers topics such as central difference interpolation formulae, interpolation with unequal intervals, numerical differentiation, numerical integration, numerical solution of ordinary differential equations, and optimization techniques.

The course emphasizes hands-on experience with numerical algorithms and optimization techniques. The course also provides an introduction to optimization techniques such as linear programming. By the end of the course, students will have developed proficiency in using numerical algorithms and optimization techniques to solve problems in various applications.

Course Purpose:

The purpose of a course on Practical **Advanced Numerical Analysis and Optimization** for an undergraduate program in Mathematics is to provide students with the necessary skills and knowledge to solve advanced mathematical problems using numerical methods and optimization techniques. The course aims to help students develop a deep understanding of advanced numerical analysis techniques and their practical applications in optimization problems.

The course will cover topics such as central difference interpolation formulae, interpolation with unequal intervals, numerical differentiation, numerical integration, and numerical solutions of ordinary differential equations. Students will learn how to use these techniques to solve optimization problems. At the end of the course, students will have a strong understanding of advanced numerical analysis and optimization techniques and will be able to apply them to solve mathematical problems in various fields.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Apply central difference interpolation formulae to interpolate a given set of data and evaluate the accuracy of the interpolation.	K_3, K_6
CO_2	Analyze the effect of unequal intervals on the accuracy of interpolation using Lagrange's interpolation formula.	K_4
CO_3	Derive and apply numerical differentiation methods such as forward difference, backward difference, and central difference to approximate the derivative of a given function.	K_3
CO_4	Evaluate the accuracy and stability of numerical integration methods such as trapezoidal rule, Simpson's rule, and Gaussian quadrature.	K_3, K_4
CO_5	Implement numerical methods such as Euler's method, improved Euler's method, and Runge-Kutta method to solve ordinary differential equations.	K_5
CO_6	Analyze the convergence, consistency, and stability of numerical methods for solving ordinary differential equations	K_6
CO_7	Recall and explain the fundamental concepts of Operations Research.	K_1, K_2
CO_8	Evaluate the feasibility and optimality of linear programming problems using graphical method and simplex method.	K_4
CO_9	Evaluate the optimal solution to transportation problems using various methods like Vogel's approximation method and MODI method.	K_4
CO_{10}	Analyze the properties of the assignment problem and formulate it using the Hungarian method.	K_6
CO_{11}	Analyze and solve sequencing problems using various methods like Johnson's rule and Branch and Bound method.	K_6

List of Practical		
Sr.	**Experiments**	**Hrs**
1	(i) Gauss forward interpolation formula. (ii) Gauss backward interpolation formula.	**6** **6**
2	Sterling's formula.	4
3	Bessel's formula.	4
4	Laplace-Everett's formula.	6
5	Interpolation with unequal intervals.	6

6	Numerical differentiation.	6
7	Numerical integration.	6
8	(i) Taylor's formula. (ii) Picard's formula. (iii) Euler's method.	4 4 4
9	(i) Runge's method (ii) Runge-Kutta's method	4 4
10	Milne's method	4
11	Solve the given LPP using Graphical method.	4
12	Solve the given LPP using Simplex method.	8
13	Solve the given LPP using BIG -M method.	6
14	Solve the given LPP using TWO-PHASE method.	6
15	Obtain DUAL of the given Primal LPP.	4
16	(i) Find the initial solution of given transportation problem using NWCM method. (ii) Find the optimum solution of given transportation problem using LCM method. (iii) Find the optimum solution of given transportation problem using VAM method.	4 4 4
17	Find the optimum solution of given transportation problem using MODI method.	6
18	Find the optimum solution of given assignment problem.	6
19	(i) Find the optimum solution of given two-person zero sum game without saddle point. (ii) Find the optimum solution of given two-person zero sum game using iterative method.	4 4
20	(i) To find optimum solution of sequencing problem with n-jobs through two machines. (ii) To find optimum solution of sequencing problem with n-jobs through three machines.	4 4

Pedagogic Tools:

- Chalk and board
- Computer Laboratory
- Power point presentation
- Seminars
- Online resources

Text Books:

- M. K. Jain, S.R.K. Iyengar and R.K. Jain, (2022), Numerical Methods, 8th Edition, New Age International Publishers, New Delhi.
- Numerical Methods with C++ Programming, (2009), Nita H. Shah, PHI Learning Pvt. Ltd.
- J. K. Sharma, (2006), Operations Research (theory and Applications), MacMillan Publishing House .
- Nita H. Shah, Gor, Ravi M. Soni, Hardik Shah, (2010), Operations Research, PHI Learning.

Reference Books:

- S. D. Conte and Carl De Boor, (2018), Elementary Numerical Analysis, 3rd Edition, McGraw-Hill, New York.
- S.S. Sastry, (2012), Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning Private Limited, New Delhi.
- R. K. Gupta, (2018), Operations Research, Krishna Prakashan Mandir, Meeut.
- Hamdy A. Taha,(2013) Operations Research: An Introduction, Pearson Education India,

Suggested reading / E-resources:

- NIST Digital Library of Mathematical Functions: https://dlmf.nist.gov/
- Wolfram MathWorld: https://mathworld.wolfram.com/
- Numerical Recipes: https://www.nr.com/
- The Netlib Repository: https://www.netlib.org/
- Coursera: https://www.coursera.org/
- Khan Academy: https://www.khanacademy.org/
- OR-Tools: https://developers.google.com/optimization
- OptaPlanner: https://www.optaplanner.org/
- Coin-OR: https://www.coin-or.org/
- AIMMS: https://www.aimms.com/english/
- GLPK: https://www.gnu.org/software/glpk/
- OpenSolver: https://opensolver.org/

Suggested MOOCs:

- Numerical Methods: https://www.edx.org/course/numerical-methods
- Introduction to Numerical Methods: https://www.futurelearn.com/courses/numerical-methods-introduction
- "Linear Optimization" on Coursera: https://www.coursera.org/learn/linear-optimization
- "Introduction to Linear Optimization" by The Hong Kong University of Science and Technology on edX: https://www.edx.org/course/introduction-to-linear-optimization
- "Discrete Optimization" by The University of Melbourne on Coursera: https://www.coursera.org/learn/discrete-optimization
- "Introduction to Operations Research" by RWTH Aachen University on edX: https://www.edx.org/course/introduction-to-operations-research.

Methods of Assessment & Tools:

Components of CIA: 40 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1-10 Experiments	$1\frac{1}{2}$ hours	15	30
	Test 2	11-20 Experiments	$1\frac{1}{2}$ hours	15	
B	Attendance and Regularity			5	10
C	Class Activities			5	
				Grand Total	**40**
Class activity	● Quiz ● Situation based question ● Handbook				

Note: Any other assessment tools or methods can be adopted as per requirement of the course

Enclosure BMTIII

Shri Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)

Affiliated to Saurashtra University, Rajkot

Trans Disciplinary Elective Course

Core Course (Theory)		
For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Mathematics**	Offered to: **All Other Departments for all B.Sc. Program**	
Semester – V		
Course Code	Course Title	Course Credit and Hours
21UMTTD01	**TDE 2: Probability & Distributions**	**2 Credits - 2 hrs/wk (2 Theory)**

Course Description:

The course on Probability & Distributions provides a comprehensive understanding of the core principles and applications of probability theory. Students will explore random experiments, sample spaces, and events, and learn to apply the laws and theorems of probability. The course covers mathematical expectation, discrete random variables, and probability distributions such as the Binomial and Poisson distributions. Students will analyze the mean, variance, and properties of these distributions, enabling them to model and solve real-world problems involving uncertainty and randomness. Through lectures, problem-solving exercises, and practical examples, students will develop the ability to apply probability theory in various fields, including finance, statistics, and decision-making.

Course Purpose:

The purpose of the course on Probability & Distributions is to equip students with a solid understanding of the fundamental concepts and applications of probability theory. The course aims to develop students' ability to analyze and quantify uncertainty, enabling them to make informed decisions in various contexts. By studying probability distributions and their properties, students will gain the necessary skills to model and solve real-world problems involving randomness and variability. The course also aims to foster critical thinking and problem-solving abilities, as students learn to apply probability theory to diverse fields such as statistics, finance, economics, and engineering. Overall, the course aims to provide a strong foundation in probability theory that prepares students for further studies and practical applications in various disciplines.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level

		(K_1 to K_6)
CO_1	Define and explain the basic concepts of probability, such as random experiments, sample spaces, and events.	K_1,
CO_2	Apply the laws of probability, such as the addition and multiplication rules, to calculate probabilities of simple and compound events.	K_2
CO_3	Analyze and evaluate the properties and characteristics of probability distributions, such as the Binomial and Poisson distributions.	K_3
CO_4	Compare and contrast different probability distributions and their applications in various fields, such as finance, statistics, and engineering.	K_4
CO_5	Design and conduct experiments to generate data and analyze it using probability distributions and statistical techniques.	K_5
CO_6	Evaluate and interpret real-world scenarios and make informed decisions based on the analysis of probabilities and distributions.	K_6

Course Contents	**Hours**
Unit-I: Set Theory & Logic	**9**
● Basic of Intuitive set theory. ● Operations for sets. ● Algebra of sets. ● Vann Diagram. ● Logic. ● The statement calculus -Truth table. ● The statement calculus -Consequence. ● The statement calculus -Applications.	
Unit-II: Probability	**10**
● Random Experiments. ● Sample Space. ● Generation of Sample Space. ● Events & Algebra or Events. ● Laws of probability. ● Theorems of probability. ● Bayes' Theorem.	
Unit- III: Mathematical Expectation	**10**
● Discrete random variable. ● Probability distributions of a discrete random variable. ● Mathematical Expectation of a discrete random variable. ● Variance of a random variable.	

Unit- IV: Probability distributions	**10**
● Introduction. ● Binomial Distribution. ● Mean and Variance of Binomial Distribution. ● Properties of Binomial Distribution.	
Unit- V: Poisson Distribution	**9**
● Poisson Distribution. ● Mean and Variance of Poisson Distribution. ● Properties of Poisson Distribution.	

Pedagogic Tools:

- Chalk and board (Lecture Method)
- Power point presentation
- Seminars
- Classroom discussions and debates
- Online resources

TEXT BOOKS: -

3. Digambar Patri, D. N. Patri, Statistical Methods, Kalyani Publications.
4. Prof. H. R. Vyas, Business Statistics, B. S. Shah Prakashan.

REFERENCE BOOKS:-

3. Nabendu Pal, Sabaded Sarkar, Statistics concepts and Applications, Prentice Hall of India.
4. J. N Kapur, H. C Saxena, Mathematical Statistics, S. Chand & Company Ltd.
5. P.S.S. Sundar Rao, J.Richard, Introduction to BioStatistics and Research Method, PHI Learning Private Ltd.

Suggested reading / E-resources:

- Probability and Statistics Resources by UCLA Statistics https://stats.idre.ucla.edu/other/progams/
- Probability Course by MIT OpenCourseWare https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/
- Statistics how to: https://www.statisticshowto.com/
- Khan Academy: https://www.khanacademy.org/
- MathisFun: https://www.mathsisfun.com/
- Wolfram MathWorld: http://mathworld.wolfram.com/

Suggested MOOCs:

- "Probability and Statistics" by Stanford University on Coursera https://www.coursera.org/learn/probability-intro
- "Introduction to Probability - The Science of Uncertainty" by edX https://www.edx.org/professional-certificate/harvardx-introduction-to-probability
- "Probability - The Science of Uncertainty and Data" by MITx on edX https://www.edx.org/professional-certificate/mitx-probability-the-science-of-uncertainty-and-data
- "Introduction to Probability and Data" by Duke University on Coursera

https://www.coursera.org/learn/probability-intro-data

- "Probability and Statistics in Data Science using Python" by UC San Diego on Coursera
  https://www.coursera.org/specializations/probability-statistics-python
- "Probability for Statistics and Data Science" by UC Santa Cruz on Coursera
  https://www.coursera.org/learn/probability-for-statistics
- "Bayesian Statistics: Techniques and Models" by UC Santa Cruz on Coursera
  https://www.coursera.org/learn/mcmc-bayesian-statistics

Methods of Assessment & Tools:

Components of CIA: 30 marks

Sr. No.	Component	Content	Duration	Marks	Sub Total
A	Test 1	1st and 2nd units	$1\frac{1}{2}$ hours	5 (Set for 30)	20
	Test 2	Remaining 3 units	2 hours	15 (Set for 70)	
B	Assignment			04	10
C	Class activity			06	
				Grand Total	**30**

Assignment	● Notes written by the learner on the different topics in the syllabus. ● Problem Solving.
Class activity	● Quiz / Surprise Quiz ● Seminar ● Situation based question etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course