નં.એકે/વિજ્ઞાન/૨૫૦૭૫૪૭/૨૦૨૫

તા.૩૦/૦૬/૨૦૨૫

<u>બી.એસસી.(ગણિતશાસ્ત્ર)</u>

પરિપત્ર:-

    સૌરાષ્ટ્ર યુનિવર્સિટીની વિજ્ઞાન વિદ્યાશાખા હેઠળની સ્નાતક કક્ષાના બી.એસસી.(ગણિતશાસ્ત્ર)ના અભ્યાસક્રમ ચલાવતી સર્વે સંલગ્ન કોલેજોના આચાર્યશ્રીઓને આથી જાણ કરવામાં આવે છે કે, અધ્યક્ષશ્રી ગણિતશાસ્ત્ર ભવન તથા વિજ્ઞાન વિદ્યાશાખાનાં ડીનશ્રી દ્વારા રજુ કરાયેલ બી.એસસી.(ગણિતશાસ્ત્ર) સેમેસ્ટર- ૦૬ નો <u>SOP મુજબનો</u> <u>અભ્યાસક્રમ</u> અધિકાર મંડળોની બહાલીની અપેક્ષાએ મંજુરી આપવા માન.કુલપતિ સાહેબને ભલામણ કરેલ જે માન.કુલપતિશ્રીએ મંજુર કરેલ છે. જેથી સંબંધિત તમામે તે મુજબ તેની અમલવારી કરવી.

(મુસદ્દો કુલસચિવશ્રીએ મંજુર કરેલ છે.)

સહી/-

(ડૉ. આર. જી. પરમાર)

I/C કુલસચિવ

બિડાણ:- ઉક્ત અભ્યાસક્રમ (સોફ્ટ કોપી)

રવાના કર્યું

વિભાગીય અધિકારી

પ્રતિ,

(૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની બી.એસસી.(ગણિતશાસ્ત્ર) વિષય ચલાવતી સ્નાતક કક્ષાની સર્વે સંલગ્ન કોલેજોના આચાર્યશ્રીઓ તથા અનુસ્નાતક ભવનનાં અધ્યક્ષશ્રીઓ તરફ.

(૨) ગણિતશાસ્ત્ર વિષયની અભ્યાસ સમિતિનાં સર્વે સભ્યશ્રીઓ

(3) ડીનશ્રી, વિજ્ઞાન વિદ્યાશાખા

<u>નકલ જાણ અર્થે રવાના:-</u>

૧. માન.કુલપતિશ્રી/કુલસચિવશ્રીના અંગત સચિવ

<u>નકલ રવાના (યોગ્ય કાર્યવાહી અર્થે):-</u>

૧. પરીક્ષા વિભાગ

૨. પી.જી.ટી.આર.વિભાગ

3. જોડાણ વિભાગ

SAURASHTRA UNIVERSITY

FACULTY OF SCIENCE

Course Structure and Syllabus for Science FYUGP

B.Sc. Honours/Honours with Research in Mathematics

Based on
UGC's guidelines NEP-2020 "Curriculum and Credit Framework for Undergraduate Programmes- CCFUP" and

Education Department, Government of Gujarat's
Uniform Credit Structure for all HEIs of Gujarat State and
Implementation of the Common Curriculum and Credit Framework under the National Education Policy-2020
(No: KCG/admin/2023-24/0607/kh.1 Sachivalaya, Gandhinagardated 11/07/2023) and

Standard Operating Procedure for Implementation of NEP-2020 for the State of Gujarat- HEIs of Gujarat
(No: KCG/admin/2023-24/865/ dated 26/07/2023) and

Additional content to be added to SOP published by KCG
(No: KCG/NEP-2020/2023-24/893/ dated 28/07/2023)

General Guidelines for Implementation of **Four Year Under Graduate Programmes** for Saurashtra University (16 pages) published in August 2023
(E-mail from Academic Section Saurashtra University dated Oct 11, 2023)

Effective From June–2025 & onwards

(Submitted on 21-06-2025)

Preface

Timely revision of the curriculum to encompass new knowledge and information is a prime criterion of IQAC and a prime need for the institute educational systems affiliated with Universities. Under the NEP - 2020 and UGC guidelines, a student must be offered the latest courses of varied requirement of technology with societal, environmental, and economic implications. The curriculum should offer multiple entry-exits and a choice of vast subjects to choose from to a student to facilitate his learning abilities, aptitude, and inclination.

Mathematics is a foundation subject for Physical & Chemical Sciences, Life Sciences, Statistics, Computer Science, Engineering, Commerce, Management, Agriculture, Environmental Science, Genetic engineering and hence holds the central position in the curriculum of these subjects. Looking at the rapid inventions and technological developments in the field of Mathematics and keeping in view the recommendations of UGC and NEP-2020, this syllabus has been formulated by the combined and coordinated efforts of all the faculty members of Mathematics Departments of all the Colleges affiliated to Saurashtra University.

The composition of a curriculum for a particular subject requires the following criteria to be considered:
1. Guidelines and Model curriculum provided by the UGC, State Government, and the University.
2. Regional needs and Present National and International trends in the subject.
3. Geographical parameters of the University and its demographic property.
4. Relationship with other related subjects and resources of educational needs.
5. Financial and statutory provisions of the State government.

The content of a syllabus should be such that it maintains continuity with the course content of higher secondary classes and post-graduate courses. Keeping this in mind, the current curriculum is made; and is an effort to impart fundamental knowledge of the subject needed at this level. The curriculum is designed as per the guidelines of UGC and NEP-2020 and reflects the courses' total credit, teaching hours, and question paper style. The syllabus units are well-defined, and the scope of each is given in detail. A list of REFERENCE BOOKS is provided at the end of each course. Mathematics being alogical and application based subject, sufficient emphasis is given to problem solving skills.

The following objectives have been considered while formulating the curriculum:

1. To provide an updated, feasible, and modern syllabus to the students, emphasizing knowledge and skill to build up their valuable college education and employment oriented carrier.
2. To frame the syllabus in accordance with the semester system, UGC – NEP 2020 guidelines and in consultation with all stakeholders.
3. To offer the students an array of Core, Interdisciplinary, Multidisciplinary, Skill enhancement, Ability enhancement and Value-added courses to select from and to facilitate their academic, intellectual and social grooming.

The Board of Studies for Mathematics expresses heartfelt gratitude to the Dean, Faculty of Science, Saurashtra University, for valuable guidelines and the Academic Section for much-needed cooperation. The Board wishes all the students a very bright future.

Prof. (Dr.) V J Kaneria	Chairman, BoS	
Prof. J. N. Chauhan	Other than Chairman, BoS	Syllabus Committee, Mathematics Saurashtra University, Rajkot (Gujarat)
Dr. G. V. Ghodasara	Subject Expert	
Dr. M. K. Kansagara	Subject Expert	
Dr. H. J. Kanani	Subject Expert	
Dr. G. K. Rathod	Subject Expert	

Date: 21st June 2025

Graduate Attributes:

Graduates should be able to demonstrate the acquisition of the following:

Academic Excellence: Comprehensive knowledge and coherent understanding of Mathematics and other interdisciplinary areas of study.

Practical, Professional and Procedural Knowledge: Required for carrying out professional or highly skilled work/tasks related to Mathematics, including knowledge required for undertaking self-employment initiatives and knowledge and mind-set required for entrepreneurship, improved product development, or a new mode of organization.

Critical and Analytical Reasoning/Thinking and Effective Communications: Analysis and evaluation of information to form a judgment about a subject or idea and ability to communicate the same in a structured form.

Research-Related Skills: the ability to understand basic research ethics and skills in Practicing /doing ethics in the field/ in personal research work, regardless of the funding authority or field of study.

Leadership Qualities and Teamwork Abilities: The graduates should be able to demonstrate the capability for mapping out the tasks of a team and setting direction and inspiring vision, and building a team that can help achieve the goals.

Global Citizenship: Mutual understanding with others from diverse cultures, perspectives, and backgrounds by embracing and practicing constitutional, humanistic, ethical, and moral values in life, including universal human values of truth, righteous conduct, peace, love, nonviolence, and scientific temper.

Life Long Learning: Ready to imbibe new knowledge, values, and skills with an open mind and willing to adopt change for constructive development.

Programme Outcomes (PO):

By the end of the program, the following programme outcomes are aimed to be achieved.

PO 1	**Disciplinary Knowledge:** Bachelor degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas.
PO 2	**Communication Skills:** Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to the proficiency in analytical reasoning which can be used for modelling and solving of real life problems.
PO 3	**Critical thinking and analytical reasoning:** The students undergoing this programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real life problems.
PO 4	**Problem Solving:** The Mathematical knowledge gained by the students through this programme develop an ability to analyse the problems, identify and define appropriate computing requirements for its solutions. This programme enhances students overall development
PO 5	**Research related skills:** The completing this programme develops the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 6	**Information/digital Literacy:** The completion of this programme will enable the learner to use appropriate software to solve system of algebraic equations and differential equations.
PO 7	**Self – directed learning:** The student completing this program will develop an ability to work independently and to make an in-depth study of various notions of Mathematics.
PO 8	**Moral and ethical awareness/reasoning:** The student completing this program will develop an ability to identify unethical behaviour such as fabrication, falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and Mathematical studies in general.
PO 9	**Lifelong learning:** This programme provides self-directed learning and lifelong learning skills. This programme helps the learner to think independently and develop algorithms and computational skills for solving real world problems.
PO 10	**Advanced Studies and Research:** Ability to pursue advanced studies and research in pure and applied Mathematical sciences.

Programme Specific Outcomes (PSO):

By the end of the program, the following programme specific outcomes are aimed to be achieved.

PSO 1	Student should be able to think in a critical manner and develop problem solving skills.
PSO 2	Students should be able to recall basic facts about mathematics and display knowledge of conventions such as notations, terminology etc.
PSO 3	Students are able to formulate and develop mathematical arguments in a logical manner.
PSO 4	It is to give in-depth knowledge of geometry, algebra, calculus, differential equations and several other branches of pure and applied mathematics. This also leads to study the related areas such as computer science and other allied subjects.
PSO 5	Students are motivated and prepared for research studies in mathematics and related fields.
PSO 6	Student should be able to apply their skills and knowledge in various fields of studies including, science, engineering, commerce and management etc.

B.Sc. Honours/ Honours with Research in Mathematics
(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)
Semester VI

SN	Course Category As per GoG- NEP-SOP - July 2023& additional content 28/7/23	Course Title	Credit			Hrs./ Wk.		Evaluation - Weightage CCE: SEE = 50:50				
			T	P	Total	T	P	CCE Marks		SEE Marks		Total Marks
								T	P	T	P	
1	**Major (Core) -14** (Mathematics)	Mathematics-14: Mathematical Analysis – I & Riemann Integrals Mathematics-14P: Programming with Python **(4- Credit Course** including Theory & Practical components)	3	1	4	3	2	25	25	50	-	100
2	**Major (Core)-15** (Mathematics)	Mathematics-15: Graph Theory & Mathematics-15P: Problem Solving in Mathematics **(4- Credit Course** including Theory & Practical components)	3	1	4	3	2	25	25	50	-	100
3	**Major (Core)-16** (Mathematics)	Mathematics-16: Optimization & Mathematics-16P: Problems on Optimization **(4- Credit Course** including Theory & Practical components)	3	1	4	3	2	25	25	50	-	100
4	**Minor(Elective)-6**	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.2) **Any One from Basket** (As per the expertise and resources available in the college) **(4- Credit Course** including Theory & Practical components)	2	2	4	2	4	25	25	50	-	100

5	**Ability Enhancement Course - 5** (AEC-5)	(As per GoG- NEP-SOP July 2023& additional content 28/7/23 – Clause 3.3.4) **English Language**	**1**	**1**	**1**	**2**	**-**	**25**	**-**	**25**	**-**	**50**
6	**Internship - 1**	As per University Guidelines	**0**	**4**	**0**	**8**	**-**	As per University Guidelines				
	Total Credits and Marks (Semester-IV)		11	08	**22**	14	16	**12 5**	150	275	-	**550**

Evaluation Scheme: (As per GoG- NEP-SOP July 2023 & additional content 28/7/23 – Chapter-7: Evaluation Reforms)

The evaluation process should be formulated to make a systematic evaluation of students' progress based on UGC guidelines. The evaluation must be designed with learner attributes in mind. These attributes have clear linkages to Programme Education Objectives and Outcomes. The evaluation consists of the following two components:

1. Continuous and Comprehensive Evaluation (CCE)- Formative
2. Semester End Evaluation (SEE)- Summative

CCE carries 50% of the total marks allotted to a subject and the other 50% being assigned to the SEE.

In each course, every credit carries 25 marks, of which 50% marks is assigned for CCE and rest 50% marks for SEE. The 50% marks assigned to the CCE is distributed between the continuous classroom evaluation and mid-term evaluation. The pattern may be as follows:

SN	Evaluation	T-3+P-1 = Total 4 credit subjects (Marks)	2 credit subjects (Marks)
1	CCE (50%)		
	Classroom & Mid-Term Evaluation	T-25+P-25	25
2	SEE (50%)	50	25
	Total	**100**	**50**

Continuous and Comprehensive Evaluation (CCE)

Subject–wise CCE will be undertaken by the concerned faculty member. The mode of evaluation will be decided by the faculty member concerned with the subject. Normally CCE consists of class participation, case analysis and presentation, assignment, tutorials, slip tests (announced/ surprised), quizzes, attendance etc. or any combination of these. The students are expected to submit their answer scripts/ reports of internal evaluation within the stipulated time. Failure to do so may result in the script not being valued. Another part of CCE consists of mid-term written evaluation, which is compulsory for all students. It can be done in a scheduled manner. The duration of the mid-term evaluation shall be one hour.

Semester End Evaluation (SEE)

The SEE carries 50% of the marks assigned to a course. SEE shall be of 2 hours for3/ 4 credit course and 2 hours in case of 1/2 credit courses. The controller of the examination will conduct these examinations. Paper setting and evaluation will be done by the external examiners to an extent of 50% of the evaluation process. This examination shall be conducted as per a schedule which shall be notified in advance.

The backlog exam will be conducted twice a year just after the result declared of the semester evaluation. Students shall have a second chance to clear their backlog and avoid the burden to carry forward the backlog with the next semester exam.

Appearance in all the evaluations is mandatory and no exemption can be granted except in the following cases:

1. In case of inability to attend the exam due to reasons considered genuine by the controller of examination in consultation with the Director/Board.

2. In case of medical emergency, a certificate from the registered medical practitioner must be produced before the commencement of exams. The evaluation board will then take final decision on the recommendation for exemption.

Eligibility Criteria to appear in SEE

To be able to appear for the SEE, a student must comply with the following conditions:

1. Should have at least 75% of attendance in all the courses put together.

2. Should have at least 70% of attendance in each course/subject.

3. Should not have any disciplinary proceedings pending against him/her.

4. Should have no pending due.

Continuum of Evaluation

Evaluation must be continuous which may include both formative and summative components in a timely manner for continuous feedback as follow:
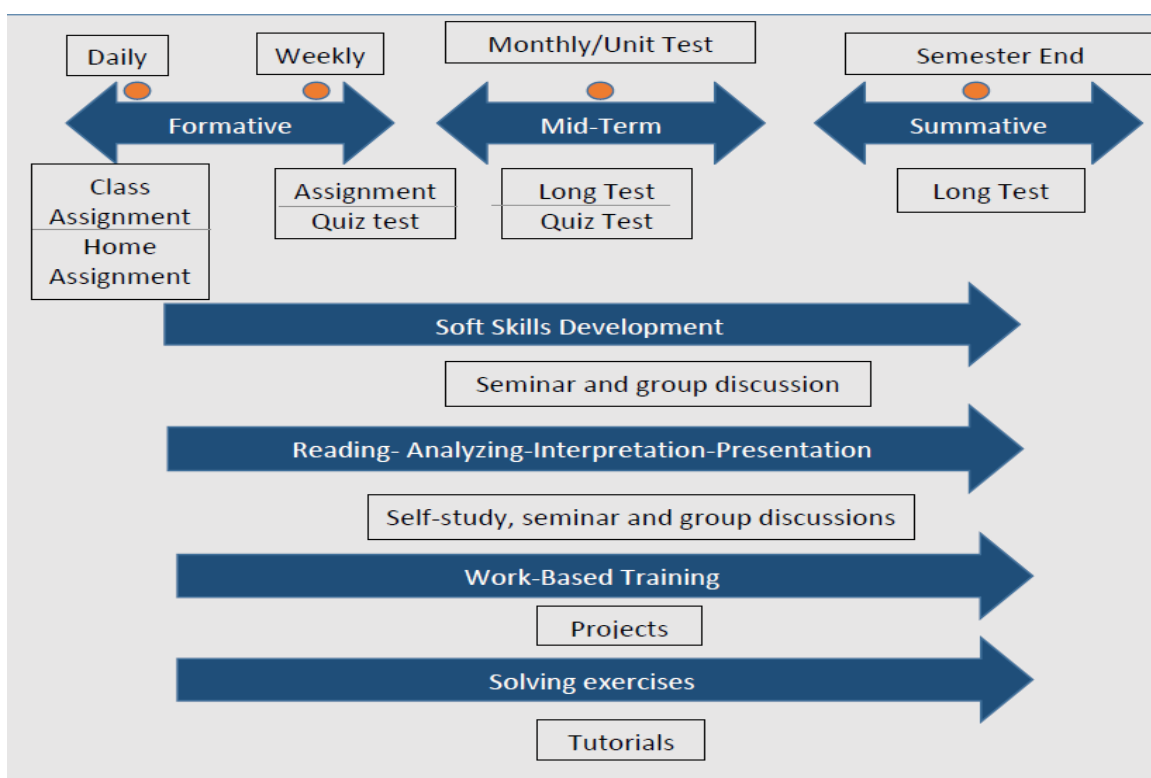
Mode of Evaluation

A wide range of modes of evaluation for evaluating students is available for the teachers/ institutions to use. A suitable compendium of such a mode needs to be carefully chosen for a particular program depending on its nature, objectives, and available resources. The mode of evaluation can be as below:

Written Mode	Oral Mode	Practical Mode	Integrated Mode
Semester Exam Class Test Open book exam/test Open note exam/test Self-test/Online test Essay/Article writing Quizzes/Objective test Class assignment Home assignment Reports writing Research/Dissertation Class Studies	Viva/Oral exam Group Discussion Role Play Authentic Problem Solving Quiz Interview	Lab work Computer simulation/virtual labs Craft work Co-curricular work	Paper presentation/Seminar Field Assignment Poster Presentation

Written Mode		
Evaluation Type	**Nature**	**Objective**
Semester Exam	Traditionally essay type with objective/short answer questions to evaluate Lower Ordered Thinking (LOT) OBE skills.	For depth and planned preparation
Class test	Traditionally essay type	Fixed date forces students to learn
Open book test	Allowed choice of reference book	Measures what students can do with resources, less stress on memory
Open note test	To get used to the system	Encourage good note taking
Self-test	For subjective and objective items	Mastery learning occurs with proper feedback
Article/essay writing	Individual long written assignment	Individual expression and creativity
Quizzes/Objective test	Short duration structured test	Excellent validity as greater syllabus coverage
Class assignment	With defined time	Student's performance to make decision
Home assignment	With undefined time	Reinforce learning and facilitate mastery of specific skills
Reports Writing	On activities performed or event observed	Develop a key transferable skill
Research/Dissertation	Detailed research-based report	To judge creativity and research skills

Case Studies	Analyse a given case (real or fictional)	To assess thinking, value, and attitude

Oral Mode		
Evaluation Type	**Nature**	**Objective**
Viva/Oral exam	Individually or in small group	Practical experience towards job interview situation
Group discussion	Small group of 2-5 members work on a joint task	Encourage teamwork
Role Play	Small group of 2-5 members work on a joint task	Develop personality
Authenticate problem solving	Small group of 2-5 members work on a joint task	Communication of ideas
Quiz	Small group of 2-5 members work on a joint task	Assess memory power
Interview	Individually	Judge the personal confidence level

Practical Mode		
Evaluation Type	**Nature**	**Objective**
Lab work	Component of working with one's hand	Keep the students on the task
Computer simulation/virtual labs	Component of working with one's hand	To understand the practical exposure
Craft work	Component of working with one's hand	Encourage application of concepts learnt
Co-curricular work	Component of working with one's hand	For immediate feedback

Integrated Mode		
Evaluation Type	**Nature**	**Objective**
Paper presentation/Seminar	Group or individual work	Learn from others presentation
Field Assignment	Field visit with report	Develop observation and recording skills
Poster presentation	Group or individual work	Develop research, creativity, and discussion skills

Models of Evaluation

Based on the types of evaluation, various models of evaluation implementation are suggested for theory, practical, self-study and work-based learning. The focus of these models is to encourage the students to improve on skills and performance.

Evaluation Norms & Question Paper Pattern for Theory & Practical Courses:
Please refer General Guidelines for Implementation of Four Year Under Graduate Programmes for Saurashtra University (16 pages) published in August 2023.

Model for Theory Courses- Theory-3+Practical-1 = 4 Credit Course	
CCE-50% (50 Marks) & SEE-50% (50 Marks)	
Exam Pattern	**Marks**
Class Test (Average of **TWO** tests)	T-25+P-25
Quiz (Average of **TWO** quizzes)	
Home Assignment	
Active Learning- PBL/CSBL/Seminar/Flipped Class Room etc..OBE tools.	
Class Assignment	
Attendance	
Continuous and Comprehensive Evaluation	
Semester-End Evaluation	**T-50**

Model for Practical Courses-1 Credit Course	
CCE-100% (25 Marks)	
Exam Pattern	**Marks**
Lab work assessment	10
Viva voce/Lab quiz	10
Attendance	05
Continuous and Comprehensive Evaluation	**25**

Model for Skill Enhancement Course - Skill based Practical Course **2 Credit (1-Theory+1-Practical=2) Course**	
CCE-50% (25 Marks) SEE-50% (25 Marks)	
Exam Pattern	**Marks**
Lab work assessment or Project based Assessment	10
Viva voce/Lab quiz	10
Attendance& Performance	05
Continuous and Comprehensive Evaluation	**25**
Semester-End Evaluation	**25**

Theory Question Paper Pattern

Semester End Examination (SEE)
Major – 4 Credit Course (Theory)

Instructions:
- All Units/ Module carry equal weightage of 10 Marks each.
- There must be One Question from each Unit/ Module.
- Time duration: 2 Hours.
- Marks: 50.

The Theory Question Paper Skeleton is as follows.

Question 1 (Unit/Module 1)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 2(Unit/Module 2)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 3(Unit/Module 3)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 4(Unit/Module 4)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 5(Unit/Module 5)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)

Theory Question Paper Pattern

Semester End Examination (SEE)
Minor – 4 (2+2) Credit Course (Theory)

Instructions:
- All Units/ Module carry equal weightage of 10 Marks each.
- There must be One Question from each Unit/ Module.
- Time duration: 2 Hours.
- Marks: 50.

The Theory Question Paper Skeleton is as follows.

Question 1 (Unit/Module 1)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 2 (Unit/Module 2)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 3 (Unit/Module 3)	Marks
A	(10/7/6/5)
B	(0/3/4/5)
OR	
A	(10/7/6/5)
B	(0/3/4/5)
Question 4 (From any Unit/Module 1/2/3)	Marks
A	(10)
B	(10)
OR	
A	(10)
B	(10)

Practical Question Paper Pattern
Semester End Examination (SEE)
Major - 4 Credit Course (Practical/Performance)

Instructions:

- Certified journal is must and minimum requirement to appearing for semester end practical examination.
- Should have at least 75% attendance in practical sessions during the semester.
- Time duration: **2** Hours.

One Practical/Performance of 25 Marks (Viva – 10 Marks & Practical – 15 Marks)

Exam Pattern	Marks
Attempt any 3 out of 5 problems. (*Each problem carry 05 Marks; Each problem may be split into sub-problem(s)/question(s), if required.)	15
Viva voce	10
CCE	**25**

B.Sc. Honours/ Honours with Research in Mathematics
(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)

Semester VI

Course Category	**Major (Core)-14**
Title of the Course	**Mathematics-14: Mathematical Analysis-II & Riemann Integral**
Course Credit	**03**
Teaching Hours per Semester	**45**
Total Marks	**CCE-25 + SEE-50**

Course Objectives

By the end of this course, learners will be able to:

1) To understand the concepts of compactness, sequential compactness, and total boundedness in metric spaces and explore their theoretical significance through examples and theorems like the Heine-Borel and Bolzano-Weierstrass Theorem.
2) To distinguish between disjoint and separated sets and study connectedness in metric spaces using key results and the Nested Interval Theorem.
3) To introduce the theory of Riemann integration, including upper and lower sums, partitions, and Darboux's approach, thereby formalizing the idea of area under a curve.
4) To examine the properties and algebra of Riemann-integrable functions and their behavior as limits of sums.
5) To explore fundamental results of integral calculus, including continuity and differentiability of primitives, and apply the Fundamental Theorem of Calculus and the Mean Value Theorem for definite integrals.

Course Outcomes– Cos

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

1) Define and recall key concepts such as compactness, connectedness, partitions, and Riemann sums.
2) Explain the meaning of open cover, sequential compactness, and Riemann integrability using appropriate examples.
3) Apply the Heine-Borel Theorem, Bolzano-Weierstrass Theorem, and Mean Value Theorem to solve theoretical and applied problems.
4) Analyze whether a given function is Riemann integrable and identify its properties through algebraic and graphical methods.
5) Evaluate the compactness and connectedness of sets in metric spaces and justify conclusions with appropriate theorems.
6) Construct Riemann sums for piecewise or simple functions and develop logical arguments to express definite integrals as limits.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?				Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?				Yes
3	Major	Yes	Minor		No
	Skill Enhancement Courses	No	Ability Enhancement Courses		No
	Value Added Courses	No	Exit/ Vocational Courses		No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?				Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?				Yes
7	Swayam પ્લેટફોર્મ પરના MOOC વિષય પર આધારિત આ વિષય છે?				No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?				No

Unit No.	Topics	Hours	Marks
I	• Definition and examples of Cover of a set. • Definition and examples of Sub cover, Open cover. • Compact sets, Results and Properties of Compact set. • Nested Interval Theorem. • Heine-Borel Theorem. • Bolzano-Weierstrass theorem.	9	10
II	• Sequential Compactness. • Totally Bounded sets. • Separated set in a metric space. • Connected set, Results and Properties of Connected set.	9	10
III	• Partitions and Riemann sums. • Upper and lower R-integrals. • Darboux's theorem (without proof). • Definition of R-integrability • Characterization of R-integrability.	9	10
IV	• Results and Properties of R-integrable function. • Some classes of R-integrable functions. • The integral as limit of sums. • Evaluation of series by integration.	9	10
V	• Continuity, Differentiability of the primitive. • Fundamental theorem of integral calculus. • Mean Value Theorem of Integral Calculus. • Problem based on Fundamental theorem and Mean Value Theorem of Integral Calculus	9	10

TEXTBOOKS: -

1. S. C. Malik & Savita Arora, (2009), *Mathematical Analysis*, New Age Int. Pvt. Ltd.
2. J. N. Sharma and A. R. Vashishtha, (2017), *Mathematical Analysis - I*, Krishna Prakashan Mandir, MEERUT(U.P.)

REFERENCE BOOKS: -

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

B.Sc. Honours/ Honours with Research in Mathematics

(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)

Semester VI

Course Category	**Major (Core)-14 Practical**
Title of the Course	**Mathematics-14P: Programming with Python**
Course Credit	**01**
Teaching Hours per Semester	**30**
Total Marks	**CCE-25**

Course Objectives

By the end of this course, learners will be able to:

1) Provide an introductory, mathematics-friendly exposure to Python syntax, data types and control structures.
2) Develop the ability to code elementary numerical and algebraic computations relevant to B.Sc. Mathematics.
3) Familiarize students with basic data analysis and visualization using NumPy & Matplotlib.
4) Cultivate algorithmic thinking by translating textbook problems into short Python programs.
5) Lay a foundation for further study in scientific computing, optimization and data science.

Course Outcomes– Cos

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

1) Define core Python terms—variable, list, loop, function.
2) Explain how control flow statements guide program execution.
3) Apply Python to compute series sums, factorials, and basic statistics.
4) Analyse output to debug logical and runtime errors in simple scripts.
5) Evaluate alternative coding approaches for efficiency and readability.
6) Create mini projects (e.g., plot of a mathematical function) integrating NumPy & Matplotlib.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?			Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?			Yes
3	Major	Yes	Minor	No
	Skill Enhancement Courses	No	Ability Enhancement Courses	No
	Value Added Courses	No	Exit/ Vocational Courses	No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No

5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?	Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?	Yes
7	Swayam પ્લેટફોર્મ પરના MOOC વિષય પર આધારિત આ વિષય છે?	No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?	No

Pr.No.	Practical
1	Python Basics: print statements, variables, data types; Computation of area & perimeter of simple shapes.
2	Control Flow: write scripts using if else, for, while to classify numbers (even/odd, prime) within a range.
3	Functions & Modules: create user defined functions for factorial, Fibonacci sequence; import math module.
4	Lists & Comprehensions: perform vector like operations on numeric lists (sum, mean, element wise square).
5	NumPy Arrays: convert lists to arrays; execute basic array arithmetic & slicing; compute dot product.
6	Plotting with Matplotlib: To plot standard known functions, Plot more than one functions (like $y = \sin x$ and $y = x^2$) on the same frame with labels and legend.
7	File I/O & Simple Statistics: read a text file of numbers, calculate mean, median, and write results to a file.
8	Mini Project: combine previous skills to simulate compound interest growth and visualise results.

TEXTBOOKS:

1) Yashavant Kanetkar, (2024), ***Python Programming – A Beginner's Guide,*** BPB Publications, NEW DELHI (Delhi), INDIA

2) Reema Thareja, (2024), ***Python Programming: Using Problem Solving Approach,*** 3rd Ed., Oxford University Press, NEW DELHI (Delhi), INDIA

3) Paul Barry, (2023), ***Head First Python,*** 3rd Ed., O'Reilly Media, SEBASTOPOL (California), USA

REFERENCE BOOKS:

1) Allen B. Downey, (2023), ***Think Python,*** 3rd Ed., Green Tea Press, NEEDHAM (Massachusetts), USA

2) Charles R. Severance, (2022), ***Python for Everybody,*** CreateSpace Publishing, SCOTTS VALLEY (California), USA

3) Wesley J. Chun, (2023), ***Core Python Programming,*** 3rd Ed., Pearson Education, NOIDA (U.P.), INDIA

No.	Practical Title
1	Write a Python program to print your name, age, and department using print().
2	Perform basic arithmetic operations: addition, subtraction, multiplication, and division on two numbers.
3	Use Python to calculate the area and perimeter of a rectangle given length and breadth.
4	Write a program to determine whether a given number is even or odd using if-else.
5	Write a program to find the maximum of three numbers using if-elif-else.
6	Implement a program to check whether a number is prime or not.
7	Display the first n Fibonacci numbers using iteration.
8	Write a function to compute the factorial of a number using both loop and recursion.
9	Input a list of integers and compute their sum and average.
10	Create a Python list and perform operations: indexing, slicing, appending, inserting, deleting elements.
11	Generate a list of squares of first n natural numbers using list comprehension.
12	Define and call user-defined functions to calculate GCD and LCM of two numbers.
13	Use Python sets to perform union, intersection, and difference of two sets.
14	Write a Python script to solve a quadratic equation.
15	Implement a menu-driven calculator using functions (add, subtract, multiply, divide).
16	Create a dictionary to store student name and marks, then print them in a formatted table.
17	Use a loop to count the number of vowels and consonants in a string.
18	Use NumPy to create 1-D and 2-D arrays and perform basic operations (addition, multiplication).
19	Use NumPy to compute mean, median, and standard deviation of a dataset.
20	Use Matplotlib to plot a simple line graph of $y = x^2$ for x in $[-10, 10]$.
21	Plot sine and cosine curves using Matplotlib on the same graph with title and legend.
22	Write a program to read a text file, count number of lines, words, and characters.
23	Simulate a simple compound interest calculator using formula: $A = P \left(1 + \frac{r}{n}\right)^{nt}$.
24	Create a basic CSV file and write marks of students, then read and display it.
25	Final mini-project: Accept x values, compute and plot $f(x) = sin(x) + cos(x)$ using NumPy & Matplotlib.

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(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)
Semester VI

Course Category	**Major (Core)-15**
Title of the Course	**Mathematics-15: Graph Theory**
Course Credit	**03**
Teaching Hours per Semester	**45**
Total Marks	**CCE-25 + SEE-50**

Course Objectives

By the end of this course, learners will be able to:

1) To introduce the fundamental concepts and terminology of graph theory, including types of graphs, degrees, and incidence relations.
2) To develop an understanding of walks, paths, circuits, and connectivity in graphs with an emphasis on Eulerian and Hamiltonian concepts.
3) To explore trees, binary trees, spanning trees, and their applications in representing hierarchical and network structures.
4) To understand and apply planar graph theory, graph coloring concepts, and chromatic numbers in various classes of graphs.
5) To apply matrix representations and algebraic structures to graphs, and study advanced concepts like vector spaces associated with graphs and connectivity in directed graphs.

Course Outcomes– COs

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

1) Define key terms and types of graphs such as simple, multi, directed, undirected, complete, bipartite, and rooted trees.
2) Explain properties and distinctions between Eulerian and Hamiltonian graphs, connected and disconnected graphs, and types of connectivity in directed graphs.
3) Apply graph-theoretic results to determine properties like connectivity, chromatic number, or Eulerian and Hamiltonian characteristics in given graphs.
4) Analyze structural features of graphs including circuits, cut-sets, and planarity using Euler's formula and subgraph relations.
5) Evaluate the chromatic number of graphs like trees, complete graphs, and bipartite graphs, and assess coloring strategies and independence sets.
6) Construct adjacency, incidence, and path matrices and use them to model problems involving network flows, connectivity, or graph traversal.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?			Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?			Yes
3	Major	Yes	Minor	No

	Skill Enhancement Courses		No	Ability Enhancement Courses	No
	Value Added Courses		No	Exit/ Vocational Courses	No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?				Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?				Yes
7	Swayam પ્લેટફોર્મે પરના MOOC વિષય પર આધારિત આ વિષય છે?				No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?				No

Unit No.	Topics	Hours	Marks
I	• Basic definitions and simple examples. • Self-loop, Parallel edges, Simple graph, Multi-graph • Directed, Undirected, mixed graph. • Incidence relation, Adjacent Vertices, Adjacent Edges. • Degree of a vertex. Odd vertex, Even vertex, Pendant vertex, Isolated vertex. • Regular graph, Null (Empty) graph, Complete graph, Complete Bipartite graph.	9	10
II	• Subgraph of a graph, Vertex-disjoint subgraphs, Edge-disjoint subgraphs. • Walk, Path, Circuit in a graph. • Connected and disconnected graphs and results based on it. • Euler graph, Unicursal graph, Results on Euler graph and Unicursal graph. • Hamiltonian path, Hamiltonian circuit and results based on it.	9	10
III	• Tree, Results on tree. • Rooted tree, Binary tree. • Spanning tree of a connected graph, Branch and Chord of a tree. • Fundamental cut-set, Fundamental circuit.	9	10
IV	• Planar graph, Kuratowski's first and second non-planar graph. • Euler's formula for planar graphs. • Dual of a planar graph. • Proper (Vertex) Colouring, Chromatic number, Results on Chromatic number of graphs like tree, complete graph, complete bipartite graph etc. • (Vertex) Independent set, Maximal independent set, Independence number, Chromatic Partitioning of a graph.	**9**	**10**

V	• Matrix representation of a graph. • Adjacency matrix, Incidence matrix, Path matrix. • Vector space associated with a graph. • Circuit subspace and cut-set subspace, Orthogonal space. • Connected directed graph, Strongly connected, Unilaterally connected and Weakly connected subgraphs of connected directed graph. • Directed circuit, Minimum decyclization of directed graphs.	**9**	**10**

TEXTBOOKS: -
1. Narsingh Deo, (1979), *Graph Theory with Applications to Engineering and Computer Science*, Prentice Hall India Learning Private Limited.
2. J. A. Clark and D. A. Holton, (1995), *First Look at Graph Theory*, Allied Publishers Ltd., World Scientific

REFERENCE BOOKS: -
1. Robin Wilson, (2002), *Introduction to Graph Theory*, 4th Edition, Pearson Education India.
2. Douglas B. West, (1996), *Introduction to Graph Theory*, Prentice Hall.

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(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)

Semester VI

Course Category	Major (Core)-15 Practical
Title of the Course	**Mathematics-15P: Problem Solving in Mathematics**
Course Credit	**01**
Teaching Hours per Semester	**30**
Total Marks	**CCE-25**

Course Objectives

By the end of this course, learners will be able to:
1) Integrate concepts from core mathematics subjects to tackle non-routine problems.
2) Cultivate a strategic approach to modelling word problems in algebraic, differential, or geometric form.
3) Strengthen computational proficiency with symbolic and numerical techniques.
4) Promote logical reasoning and proof skills through group discussion of solution paths.
5) Prepare students for competitive examinations, research projects, and real-life analytical tasks.

Course Outcomes– COs:

Upon completion of this course, the learner will be able to
1) Recall standard derivative, integral, matrix, and group identities.
2) Describe the step-by-step process of formulating an ODE from a verbal description.
3) Summarize criteria for analyticity and differentiability in the complex plane.
4) Apply matrix techniques to solve linear systems arising in geometric contexts.
5) Analyze the behavior of a function by combining derivative tests and geometric insight.
6) Evaluate multiple integration methods (residues vs. direct, substitution vs. parts) for efficiency.
7) Synthesize group-theoretic and ring-theoretic ideas to classify algebraic structures.
8) Design a mathematical model for a real-world scenario and validate it with data.
9) Create a comprehensive solution report, articulating reasoning and alternative strategies.
10) Critique peer solutions, offering constructive feedback grounded in mathematical rigor.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?			Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?			Yes
3	Major	Yes	Minor	No
	Skill Enhancement Courses	No	Ability Enhancement Courses	No
	Value Added Courses	No	Exit/ Vocational Courses	No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?			Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?			Yes
7	Swayam પ્લેટફોર્મ પરના MOOC વિષય પર આધારિત આ વિષય છે?			No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?			No

Pr. No.	Practical
1	Solve the problems on continuity and differentiability of function of one variables.
2	Solve the problems on Integral Calculus.
3	Formation of Differential Equations of first and higher order from word problems of different fields and solve them.
4	Solve different problems in Linear Algebra. (a) Problems on Matrices and Determinants (b) Problems on Linear Transformation
5	Solve the problems in Complex Analysis based on Analytic function, Maximum Modulus Principle etc.
6	Solve the problems in Complex Analysis based on Line Integral, Complex integration etc.
7	Solve different problems in Abstract Algebra (Group Theory): Problems on Groups, Cyclic groups, Permutation groups etc.
8	Solve different problems in Abstract Algebra(Ring Theory): (a) Problems on Rings, Polynomial Ring etc. (b) Basic problems on Fields.
9	Solve the problems based on two dimensional and three dimensional Geometry.
10	General Mathematical Problems.

Textbooks:

1) George B. Thomas et al., (2022), ***Thomas' Calculus,*** 15th Global Ed., Pearson Education, NOIDA, INDIA

2) M. D. RaiRaisinghania, (2017), Ordinary and Partial Differential Equations, 19th Edition, S Chand & Company Limited.

3) Gilbert Strang, (2023), ***Linear Algebra and Learning from Data,*** Latest Reprint, Wellesley Cambridge Press, USA

4) John B. Conway, (2021), ***Functions of One Complex Variable,*** 3rd Ed., Springer Nature, GURUGRAM, INDIA

5) Joseph A. Gallian, (2023), ***Contemporary Abstract Algebra,*** 11th Int. Ed., Cengage Learning, NEW DELHI, INDIA

Reference Books:

1) Howard Anton & Chris Rorres, (2022), ***Elementary Linear Algebra: Applications*** Version, 12th Ed., Wiley India, NEW DELHI, INDIA

2) James Stewart, (2023), ***Essential Calculus – Metric*** Version, 9th Reprint, Cengage Learning, NEW DELHI, INDIA

3) Richard Bronson & Gabriel Costa, (2022), ***Schaum's Outline of Differential Equations,*** 4th Ed., McGraw Hill Education, CHENNAI, INDIA

4) Murray R. Spiegel, (2024), ***Schaum's Outline of Complex Variables***, 3rd Ed., McGraw Hill Education, CHENNAI, INDIA

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Semester VI

Course Category	**Major (Core)-16**
Title of the Course	**Mathematics-16: Optimization**
Course Credit	**03**
Teaching Hours per Semester	**45**
Total Marks	**CCE-25 + SEE-50**

Course Objectives

By the end of this course, learners will be able to:

1) To provide a foundational understanding of the principles, development, and scope of Operations Research in solving real-world decision-making problems.
2) To equip students with the knowledge to formulate and solve linear programming problems using various standard forms and methods.
3) To develop analytical skills for solving optimization problems using the Simplex method, Big-M method, and Two-Phase method.
4) To introduce students to duality theory and the basics of Game Theory for handling competitive decision-making situations.
5) To enable students to model and solve transportation, assignment, and sequencing problems using algorithmic techniques.

Course Outcomes– Cos

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

1) Recall basic concepts, definitions, and historical background of Operations Research and Linear Programming.

2) Explain the formulation of a Linear Programming Problem and the structure of its standard and matrix forms.

3) Apply the graphical method, Simplex method, Big-M method, and Two-Phase method to solve various types of linear programming problems.

4) Analyze and compare the dual and primal forms of LPP and interpret the solutions in the context of optimization.

5) Evaluate optimal strategies in two-person zero-sum games using game-theoretic principles such as minimax, maximin, and dominance rules.

6) Design and solve real-life problems using appropriate Operations Research techniques in transportation, assignment, and sequencing scenarios.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?					Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?					Yes
3	Major	Yes		Minor		Yes
	Skill Enhancement Courses	No		Ability Enhancement Courses		No
	Value Added Courses	No		Exit/ Vocational Courses		No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?					Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?					Yes
7	Swayam પ્લેટફોર્મે પરના MOOC વિષય પર આધારિત આ વિષય છે?					No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?					No

Unit No.	Topics	Hours	Marks
1	**Introduction to Operations Research** • Basic 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	9	10
2	**Linear Programming** • Basic definitions required for Simplex method. • Simplex method (algorithm) to solve LPP, Examples on Simplex method • Big-M method (Penalty method) to solve LPP • Two phase method to solve LPP	9	10
3	**Duality in LPP and Game Theory** • 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.	9	10

4	**Transportation Problems** • 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)		**9**	**10**
5	**Assignment problems and Sequencing Problems** • 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.		**9**	**10**

Textbooks:
1. J. K. Sharma, (2023), *Operations Research (theory and Applications),* MacMillan Publishing House, New Delhi (Delhi), India.
2. Hamdy A. Taha, (2019), *Operations Research: An Introduction,* 10th edition, Pearson Education India, Noida (U.P.), India.

Reference Books:
1. R. K. Gupta, (2021), *Operations Research,* 2nd edition, Krishna Prakashan Media Pvt. Ltd., Meerut (U.P.), India.
2. Nita H. Shah, Gor, Ravi M. Soni, Hardik Shah, (2019), *Operations Research,* 2nd edition, PHI Learning Pvt. Ltd., New Delhi (Delhi), India.

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(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)

Semester VI

Course Category	**Major (Core)-16 Practical**
Title of the Course	**Mathematics-16P: Practicals on Optimization**
Course Credit	**01**
Teaching Hours per Semester	**30**
Total Marks	**CCE-25**

Course Objectives

By the end of this course, learners will be able to:
1) To familiarize students with the computational implementation of optimization techniques.
2) To train students to solve linear programming problems using graphical and algebraic methods.
3) To provide hands-on experience in using the Simplex, Big-M, and Two-Phase methods for optimization.
4) To expose students to practical models of transportation, assignment, and game theory problems.
5) To enable students to solve sequencing problems using efficient algorithms in a stepwise manner.

Course Outcomes– Cos

Upon completion of this course, the learner will be able to
1) Recall and explain key optimization algorithms such as Simplex, Big-M, and Two-Phase methods.
2) Interpret the mathematical structure of linear programming, transportation, and assignment problems.
3) Apply optimization techniques to solve LPPs using graphical, simplex, and modified simplex methods.
4) Analyze and compare the efficiency of different methods (NWCM, LCM, VAM, MODI) used in transportation problems.
5) Evaluate the strategies for solving two-person zero-sum games with or without a saddle point using game-theoretic tools.
6) Develop optimal sequencing plans for jobs processed through two or three machines using appropriate algorithms.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?				Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?				Yes
3	Major	Yes	Minor		No
	Skill Enhancement Courses	No	Ability Enhancement Courses		No
	Value Added Courses	No	Exit/ Vocational Courses		No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	No
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?				Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?				Yes
7	Swayam પ્લેટફોર્મે પરના MOOC વિષય પર આધારિત આ વિષય છે?				No
8	ઈન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?				No

Pr.No.	Practical
1	Solve the given LPP using the Graphical method.
2	Solve the given LPP using the Simplex method.
3	Solve the given LPP using the BIG -M method.
4	Solve the given LPP using the TWO-PHASE method.
5	Obtain DUAL of the given Primal LPP. three machines.
6	(i) Find the initial solution of a given transportation problem using the NWCM method. (ii) Find the optimum solution of a given transportation problem using the LCM method. (iii)Find the optimum solution to a given transportation problem using the VAM method.
7	Find the optimum solution to a given transportation problem using the MODI method.
8	Find the optimum solution to the given assignment problem.
9	(i) Find the optimum solution of a given two-person zero-sum game with saddle point. (ii) Find the optimum solution of a given two-person zero-sum game without saddle point.
10	(i) To find the optimum solution to the sequencing problem with n-jobs through two machines. (ii) To find the optimum solution to the sequencing problem with n-jobs through three machines.

Textbooks:

1. J. K. Sharma, (2023), *Operations Research (theory and Applications),* MacMillan Publishing House, New Delhi (Delhi), India.
2. Hamdy A. Taha, (2019), *Operations Research: An Introduction,* 10th edition, Pearson Education India, Noida (U.P.), India.

Reference Books:

1. R. K. Gupta, (2021), *Operations Research,* 2nd edition, Krishna Prakashan Media Pvt. Ltd., Meerut (U.P.), India.
2. Nita H. Shah, Gor, Ravi M. Soni, Hardik Shah, (2019), *Operations Research,* 2nd edition, PHI Learning Pvt. Ltd., New Delhi (Delhi), India.

B.Sc. Honours/ Honours with Research in Mathematics

(NCrF Level- 5.5 Third Year – Bachelor in Mathematics)

Semester VI

Course Category	**Minor (Elective)-6**
Title of the Course	**Mathematics-6: Introduction to Number Theory**
Course Credit	**02**
Teaching Hours per Semester	**30**
Total Marks	**CCE-25 + SEE-50**

Course Objectives

Upon completion of the course students will be able to
1) Prove results involving divisibility and greatest common divisors.
2) Solve systems of linear congruences.
3) Find integral solutions to specified linear Diophantine Equations.
4) Apply Euler-Fermat's Theorem to prove relations involving prime numbers.
5) Apply the Wilson's theorem.

Course Outcomes– Cos

Upon completion of this course, the learner will be able to
1) Recall the definitions of divisibility, congruence, prime and composite numbers, and common arithmetic functions $\phi(n)$, $\tau(n)$, $\sigma(n)$.
2) State the Fundamental Theorem of Arithmetic and the Chinese Remainder Theorem clearly and accurately.
3) Apply modular arithmetic techniques to solve linear congruences and systems via the Chinese Remainder Theorem.
4) Analyze integer sequences using $\phi(n)$, $\tau(n)$, $\sigma(n)$ and interpret the arithmetic information they reveal.
5) Critique alternative solution strategies for linear Diophantine equations, judging their efficiency and elegance.
6) Design algorithms for prime detection and integer factorisation grounded in the studied theorems.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?			Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?			Yes
3	Major	No	Minor	Yes
	Skill Enhancement Courses	No	Ability Enhancement Courses	No

	Value Added Courses	No	Exit/ Vocational Courses		No
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	Yes
5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?				Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?				Yes
7	Swayam પ્લેટફોર્મ પરના MOOC વિષય પર આધારિત આ વિષય છે?				No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?				No

Unit No.	Topics	Hours	Marks
I	- Well Ordering Principle, Principle of Mathematical Induction. - Divisibility, Problems based on divisibility, Division Algorithm. - Representation of integers in different bases. - The Greatest Common Divisor (GCD). - The Euclidean Algorithm (without proof), Lame's Theorem.	9	15
II	- Least Common Multiple (LCM) - Linear Diophantine Equations - Prime Numbers and Composite Numbers - Fundamental Theorem of Arithmetic (without proof) - Canonical decomposition of integers, GCD & LCM of integers using Canonical decomposition - The Sieve of Eratosthenes method. - The Integral part function (Greatest Integer Function-GIF), Fractional Part Function (FPF), Results and properties of GIF & FPF.	12	20
III	- Euler's Phi function and its properties. - The functions $\tau(n)$ and $\sigma(n)$ - Theory of Congruence: Definition and basic properties of congruence, Residue class & Complete system of residues. - Fermat's Theorem, Euler's Theorem - Wilson's Theorem (Without Proof). - Problems based on Euler's, Fermat's theorem and Wilson's Theorem. - The Chinese Remainder Theorem (Without proof), Problems based on Chinese Remainder Theorem.	9	15

TEXTBOOKS: -
  1. Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.

REFERENCE BOOKS: -
  1. An introduction to the Theory of numbers - Niven and Zuckerman, Wiley Eastern Ltd.
  2. Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag.
  3. Elementary Theory of Numbers - C. Y. Hsiung, Allied Publishers Ltd.-India.
  4. Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press.

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Semester VI

Course Category	Minor-6 Practical
Title of the Course	Mathematics 6P: Practicals on Number Theory
Course Credit	02
Teaching Hours per Semester	60
Total Marks	CCE-25

Course Objectives

Upon completion of the course students will be able to

1) Strengthen procedural fluency with classical number-theoretic algorithms (GCD, LCM, modular arithmetic).
2) Apply induction and congruence principles to prove properties of integer sequences and special numbers.
3) Investigate and compute arithmetic functions (τ, σ, highest-power in n!) for large integers using software or manual methods.
4) Analyze theorems of Fermat, Euler, and Wilson through hands-on problem sets and computational experiments.
5) Develop critical thinking by characterizing divisibility conditions and designing efficient solution strategies.

Course Outcomes

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

1. Recall basic facts about perfect, Mersenne, and Fermat numbers.
2. Describe the principle of mathematical induction and its application to finite sums.
3. Apply the Euclidean Algorithm and prime-factor methods to compute GCD, LCM, $\tau(n)$, and $\sigma(n)$.
4. Analyze Fibonacci properties by constructing inductive proofs and recognising pattern growth.
5. Evaluate the efficiency of different tests for divisibility (mod 2^k, 3, 11, 37, 101).
6. Create original congruence-based algorithms to detect primality or specific divisibility traits.

1	Employability/Entrepreneurship/Skill Development પર કેન્દ્રિત થયેલ છે કે નહિ?			Yes
2	Value added Courses Imparting Transferable and Life Skills ના ગુણો ધરાવે છે?			Yes
3	Major	No	Minor	Yes

	Skill Enhancement Courses	No	Ability Enhancement Courses	No	
	Value Added Courses	No	Exit/ Vocational Courses	No	
4	Holistic Education	Yes	Multidisciplinary	No	Interdisciplinary	Yes

5	દિવ્યાંગ માટે વિષય અંતર્ગત આનુસાંગિક જોગવાઈ કરાયેલ છે?	Yes
6	New India Literacy Programme (NILP) મુજબનો વિષય છે?	Yes
7	Swayam પ્લેટફોર્મે પરના MOOC વિષય પર આધારિત આ વિષય છે?	No
8	ઇન્ડીયન નોલેજ સીસ્ટમ (IKS) પર આધારિત વિષય છે?	No

PN	Practical
1	To solve problems using principle of mathematical induction related to Finite sum.
2	To prove properties of Fibonacci sequence using principle of mathematical induction.
3	To study definition and properties of Perfect, Mersenne prime and Fermat numbers.
4	(a) To find GCD and LCM of large integers. (b) To find number of divisors, sum of divisors of large integers (c) To find highest power of prime in $n!$ and problem based on it.
5	Problems based on Fermat's Theorem.
6	Problems based on Euler's Theorem.
7	Problems based on Wilson's Theorem.
8	Application of congruence to Characterization of divisibility of an integer N by $2^k, 5, 10$ and problems based on it.
9	Application of congruence to Characterization of divisibility of an integer N by $3, 9, 11$ and problems based on it.
10	Application of congruence to Characterization of divisibility of an integer N by $(7\ or\ 3), 37, 101$ and problems based on it.

TEXTBOOKS: -
1. Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.

REFERENCE BOOKS: -
1. An introduction to the Theory of numbers - Niven and Zuckerman, Wiley Eastern Ltd.
2. Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag.
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4. Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press.

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Semester VI

<u>INTERNSHIP (4 Credit Course)</u>

Student will undergo Internship as per Saurashtra University Guidelines.

Based on Framing of Uniform Credit Structure for all Higher Educational Institutions of the State and Implementation of the Common Curriculum and Credit Framework under the National Education Policy-2020 - GR No. KCG/admin/2023-24/0607/kh.1 dated 11/07/2023.

Standard Operating Procedure published from Saurashtra University, Rajkot on Date – 10/10/2023 /General Guidelines for implementation of four-year undergraduate programmes.

• પરિપત્ર:-નં. એકે/૯૦૮૮૨/૨૦૨૩ :તા.૧૦/૧૦/2023

• પરિપત્ર:- નાં. એકે/બી.એસ./2504538/૨૦૨૫ તા. ૩૧/૦૫/૨૦૨૫

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