Annamalai University

(Accredited with 'A' Grade by NAAC)

Faculty of Science

Regulations, Curriculum and Syllabus
2019

M.Sc. MATHEMATICS

Programme Code: SMAT21

Department of Mathematics

Annamalai University

Faculty of Science

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS

Programme Code: SMAT21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Mathematics** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science Two year M.Sc. Mathematics Regulations 2019**". .They shall come into force with effect from the academic year 2019 – 2020.

1. **Definitions and Nomenclature**

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centers at the University.

1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.

1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.

1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/ Laboratory /Seminar/Project work/viva-voce etc. Each course has a course title and is identified by a course code.

1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.

1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.

1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.

1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days.

1.10 **Choice Based Credit System**: A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.

1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.

1.12 **Elective Course** is a course that a student can choose from a range of alternatives.

1.13 **Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.

1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.

1.16 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.

1.17 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.

1.18 **Learning Objectives** are statements that define the expected goal of a course in **Course Objectives** in terms of demonstrable skills or knowledge that will be acquired by a student.

1.19 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.

1.20 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3

1.21 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. is given in section11.4.

1.22 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2 Programme Offered and Eligibility Criteria:

The Department of Mathematics offers a M.Sc. Two-Year Mathematics programme.

A pass in B.Sc. (Mathematics) with not less than 50% of marks in Part–III.

3 **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4 Programme Duration

4.1 The Two-Year Master's Programme consist of two academic years.

4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.

4.3 Each semester will have 90 working days (18 weeks).

5. Programme Structure

5.1 The Two-Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 Core courses

5.2.1 These are a set of compulsory courses essential for each programme.

5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 Elective courses

5.3.1 Departmental Electives (DEs) are the Electives that students can choose from a range of Electives offered within the Department.

5.3.2 Interdepartmental Electives (IDEs) are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.4 Experiential Learning

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trips/internships/industrial visits fall under this category.

5.5 Project

5.5.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor will be from the host institute.

5.6 Value added Courses (VACs)

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the Handbook, available in the University Website.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction. Classes for a VAC are conducted beyond the regular class hours and preferably in the III Semester.

5.7 **Online Courses**

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 **Credit Distribution:** The credit distribution is organized as follows:

	Credits
Core Courses	74
Elective Courses	15
Constitution of India	2*
Project	06
Total	**95**

Note: * Non-credit compulsory course.

5.9 **Credit Assignment**

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

1 Tutorial period of one hour duration per week over a semester

1 Practical / Project period of two hours duration per week over a semester.

6 **Attendance**

6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.

6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.

6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.

6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.

6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.

6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.

7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.

7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).

8.2 There will be two CIA Tests and one ESE in each semester.

8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The question paper will be set by the respective faculty using Bloom's Taxonomy.

8.4.4 CIA Test – I will cover the syllabus of the first two units while CIA Test – II will cover the last three units.

8.4.5 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.

8.4.6 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special

test lies with the teacher in consultation with the Head of the Department.

8.4.7 For the CIA Tests, the assessment will be done by the Course teacher.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the Odd semester will be conducted in November and for the Even semester in May.

8.6 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.

8.7 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses and project, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.2 Assessment of CIA Tests

9.2.1 For the CIA Tests, the assessment will be done by the Course Teacher

9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

CIA for Theory	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

CIA for Practical	Marks
Test-I	15
Test-II	15
Viva-voce and Record	10
Total	40

9.3 **Assessment of End-Semester Examinations**

9.3.1 Evaluation for the ESE is done by Internal examiner.

9.4 **Assessment of Project/Dissertation**

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.

9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.

9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work, attendance etc.

9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.

9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		**End Semester Examination (75 Marks)**	
Review-I - 10	Review-II -15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 **Assessment of Value-added Courses**

9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted by the Department(s) offering VAC.

9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 **Passing Minimum**

9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.2 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. **Conferment of the Master's Degree**

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. **Marks and Grading**

11.1 The performance of students in each course is evaluated in terms Grade Point (GP).

11.2 The sum total performance in each semester is rated by Grade Point Average (GPA)

while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.

11.3 **The GPA** is calculated by the formula

$$GGG = \frac{\sum_{G=1}^{G} G_G G_G}{\sum_{G=1}^{G} G_G}$$

where G_G is the Credit earned for the Course G in any semester;

G_G is the Grade Point obtained by the student for the Course G

G is the number of Courses passed in that semester.

11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$GGGG = \frac{\sum_{G=1}^{G} \sum_{G=1}^{G} G_G G_G}{\sum_{G=1}^{G} \sum_{G=1}^{G} G_G}$$

Where, G_G is the Credit earned for the Course G in any semester;

G_G is the Grade Point obtained by the student for the Course G

G is the number of Courses passed in that semester.

G is the number of semesters.

11.5 **Evaluation :**

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten-point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	Classification of Final Result
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6 **Classification of Results**. The successful candidates are classified as follows:

11.6.1 **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme in the first attempt with a CGPA of 8.25and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

11.6.2 **First Class:** Candidates who have passed all the courses with a CGPA of 6.5and above.

11.6.3 **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.

11.6.4 Candidates who obtain overall highest CGPA in all examinations in the first appearance itself are eligible for **University Rank.**

11.7 **Course-Wise Letter Grades**

11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.

11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.

11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point

11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade sheet of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.

11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. **Provision for Withdrawal from the End Semester Examination**

12.1 The letter grade W indicates that a candidate has withdrawn from the examination.

12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.

12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.

12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.

12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days' notice, due consideration will be given under extraordinary circumstances.

12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. **Academic misconduct:** Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.

14. **Transitory Regulations:** Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.

15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two-Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.

M.Sc. Mathematics (Two Year) ProgrammeSMAT21

CURRICULA AND SCHEME OF EXAMINATIONS (2019)

Course Code	Course Title	Hours per week			Credit	Marks		
		L	T	P	C	CIA	ESE	Total
	FIRST SEMESTER							
19MATC101	Core 1: Advanced Abstract Algebra I	5			5	25	75	100
19MATC102	Core 2: Advanced Real Analysis	5			5	25	75	100
19MATC103	Core 3: Advanced Differential Equations	5			5	25	75	100
19MATC104	Core 4: Differential Geometry	5			5	25	75	100
19XXXXXXX	Elective 1: Interdepartmental Elective	3			3	25	75	100
	Total credits-Semester I				**23**			
	SECOND SEMESTER							
19MATC201	Core 5: Advanced Abstract Algebra II	5			5	25	75	100
19MATC202	Core 6: Measure Theory and Integration	5			5	25	75	100
19MATC203	Core 7: Advanced Complex Analysis	5			5	25	75	100
19MATP204	Core 8: C++ Computer Practical			4	2	40	60	100
19MATE205	Elective 3: Department Elective Programming Language C++	3			3	25	75	100
19SPHYX01	Elective 2: Interdepartmental Elective Classical Mechanics and Special Theory of Relativity	3			3	25	75	100
	Total credits-Semester II				**23**			
	THIRD SEMESTER							
19MATC301	Core 9: Topology	5			5	25	75	100
19MATC302	Core 10: Linear Algebra	5			5	25	75	100
19MATC303	Core 11: Probability Theory	5			5	25	75	100
19MATP304	Core 12: Numerical Methods Practical			4	2	40	60	100
19MATE30X	Elective 5: Department Elective	3			3	25	75	100
19XXXXXXX	Elective 4: Interdepartmental Elective	3			3	25	75	100
19PSCI300	Constitution of India	2			2*	25	75	100
	Total credits-Semester III				**23**			

Course Code	Course Title	Hours per week			Credit	Marks		
		L	T	P	C	CIA	ESE	Total
FOURTH SEMESTER								
19MATC401	Core 13: Functional Analysis	4			4	25	75	100
19MATC402	Core 14: Stochastic Processes	4			4	25	75	100
19MATC403	Core 15: Fluid Dynamics	4			4	25	75	100
19MATC404	Core 16: Graph Theory	4			4	25	75	100
19MATC405	Core 17: Calculus of Variations & Integral Equations	4			4	25	75	100
19MATD406	Project (Dissertation & Viva-voce)		6		6	25	75	100
	Total credits-Semester IV				**26**			
	Semesters I-IV Total Credits				**95**			
Value added Courses								
On-line courses (SWAYAM or MOOC)								

* Non credit compulsory course

L- Lectures; **T**- Tutorial; **P**- Practical; **C**- Credits; **CIA**- Continuous Internal Assessment; **ESE**- End-Semester Examination

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available. The details of interdepartmental electives are given in the **"Handbook of Interdepartmental Electives- PG Programmes"** and listed in the University website.
2. Students may opt for any Value Added Courses listed in the University website. The details of Value Added Courses are given in the **"Handbook of Value Added Courses"** and listed in the University website.
3. Guidance/Discussion with students on course specific **experiential learning** through the application of theory and academic content to real-world experiences, either within the classroom, within the community, or within the work place, which advances program or course -based learning outcome that are specifically focused on employability skills.

DEPARTMENT ELECTIVE COURSES (DE)

S. No.	Course Code	Course Title	Hours/ week			C	Marks		
			L	T	P		CIA	ESE	Total
1.	19MATE205	Programming Language C++	3	0	0	3	25	75	100
2.	19MATE306	Number Theory	3	0	0	3	25	75	100
3.	19MATE307	Fuzzy Sets and their Applications	3	0	0	3	25	75	100

ANNAMALAI UNIVERSITY

Department of Mathematics

[Question Paper Pattern - INTERNAL TESTS I & II (CIA)]

(Based on Revised Bloom's Taxonomy)

Programme: M.Sc : Two Year PG **Semester: All**

Time: 2 Hrs **Max.Marks:50**

Part-A (Level-K1) **Marks: (6x2=12)**

(Answer ALL of the questions)

1. Define /Choose/ Relate……
2. What / Why / How?
3. Multiple Choices a. b. c. d.
4. Multiple Choices a. b. c. d.
5. Match the following i - a ii - b iii - c iv - d v - …..
6. Match the following i - a ii - b iii - c iv - d v - …..

Part-B (Level-K2) **Marks: (3x5=15)**

(Answer any THREE of the questions)

7. Explain…..
8. Describe…..
9. Select……
10. Compare

Part-C (Level-K3/ Level-K4) **Marks: (2x7=14)**

(Answer any TWO of the questions)

11. Apply….
12. Calculate….
13. Categorize…

Part-D (Level-K5/ Level-K6) **Marks: (1x9=9)**

(Answer any ONE of the questions)

14. Discuss….
15. Summarize….

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Pattern of question paper for END semester examinations

(Based on Revised Bloom's Taxonomy)

Year : I

Programme: M.Sc. Two Year PG Programme **Semester: I / II**

Course Code: **Course Name:**

Time: 3 Hrs **Max.Marks:100**

Part-A (Level-K1/ Level-K2) Marks: (10x2=20)

(Answer ALL of the questions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe……
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4)Marks: (8x5=40)

(Answer any EIGHT of the questions)

11. Prepare…..
12. Solve…..
13. Apply……
14. Show…..
15. Categorize…
16. Analyze…
17. Distinguish….
18. Infer….
19. Compare….
20. Compute

Part-C (Level-K5)Marks: (3x10=30)

(Answer any THREE of the questions)

21. Discuss…
22. Summarize….
23. Evaluate…..
24. Disprove….

Part-D (Level-K6)*Marks: (1x10=10)

(Answer any ONE of the questions)

25. Design….
26. Develop…

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Year : II

Programme: M.Sc Two Year PGProgramme Semester: III / IV

Course Code: Course Name:

Time: 3 Hrs Max.Marks:100

Part-A (Level-K1/ Level-K2)Marks: (10x2=20)

(Answer ALL of thequestions)

1. Define……
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv –d v - …..
5. Match the following i - a ii- b iii- c iv –d v - …..
6. Explain…….
7. Select…..
8. Describe…..
9. Classify….
10. Elucidate….

Part-B (Level-K3/ Level-K4)Marks: (6x5=30)

(Answer any SIX of the questions)

11. Apply……
12. Show…..
13. Prepare
14. Make use of….
15. Categorize…
16. Analyze…
17. Distinguish….
18. Simplify…..

Part-C (Level-K5)Marks: (3x10=30)

(Answer any THREE of the questions)

19. Discuss…
20. Recommend with
21. Evaluate…..
22. Justify….
23. Optimize…

Part-D (Level-K6)*Marks: (2x10=20)

(Answer any TWO of the questions)

24. Design….
25. Formulate …
26. Modify …..

M.Sc.Mathematics(TWO YEAR) PROGRAMME								
[End Semester Examinations] Bloom's Taxonomy - Questions Conforming to Levels K1 to K6								
	I Year (Two year PG)					II Year (Two Year PG)		
	Level	Part	Questions & Marks	Total Marks		Level	Part	Questions & Marks	Total Marks
	K1	A	5 x 2	10		K1	A	5 x 2	10
	K2		5 x 2	10		K2		5 x 2	10
	K3	B	4 x5	20		K3	B	2 x 5	10
	K4		4 x5	20		K4		4 x 5	20
	K5	C	3 x 10	30		K5	C	3 x10	30
	K6	D	1 x 10	10		K6	D	2x 10	20
				100					100

PROGRAMME OUTCOMES (POs)

After the successful completion of the M.Sc Mathematics (2 year) Degree Programme, the graduates will be able to:

PO1:	Domain knowledge: Demonstrate knowledge of basic concepts, principles and applicationsof the specific science discipline.
PO2:	Resource Utilisation. Cultivate the skills to acquire and use appropriate learning resourcesincluding library, e-learning resources, ICT tools to enhance knowledge-base and stayabreast of recent developments.
PO3:	Analytical and Technical Skills: Ability to handle/use appropriatetools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4:	Critical thinking and Problem solving: Identify and critically analyse pertinent problems inthe relevant discipline using appropriate tools and techniques as well as approaches toarrive at viable conclusions/solutions.
PO5:	Project Management: Demonstrate knowledge and scientific understanding to identifyresearch problems, design experiments, use appropriate methodologies, analyse andinterpret data and provide solutions. Exhibit organisational skills and the ability to managetime and resources.
PO6:	Individual and team work: Exhibit the potential to effectively accomplish tasksindependently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7:	Effective Communication: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large.Demonstrate the ability to write dissertations, reports, make effective presentations anddocumentation.
PO8:	Environment and Society: Analyse the impact of scientific and technological advances onthe environment and society and the need for sustainable development.
PO9:	Ethics: Commitment to professional ethics and responsibilities.
PO10:	Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the programme, the student will be able to

PSO1	Improve the problems solving skills.
PSO2	Collaborate with the other related areas of science.
PSO3	Improve the theoretical knowledge of Mathematical concepts.
PSO4	Creatively applying the knowledge of Mathematics in selected reallife situations / Ability to acquire knowledge for studying higher level abstract mathematics.

Semester	19MATC101: Advanced Abstract Algebra – I	L	T	P	C
I		5	0	0	5

Learning Objective (LO):

LO1	This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics.
LO2	The focus of the course will be the study of certain structures called groups and some related structures.
LO3	Some advanced concept of groups, Dihedral groups are introduced. Homomorphsims and Isomorphisms, cyclic groups, permutation groups, Sylow's theorem, direct and semi-direct products are studied.

Course Outcomes (CO)

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

CO1	give examples and counter examples
CO2	understand techniques
CO3	solve problems of various concepts in: • Groups, • Quotient Groups, • Homomorphism of Groups, • Group Actions, • Direct products of Groups.

Unit-1: Introduction to groups:

Dihedral groups - Symmetric groups - Matrix groups - Homomorphisms and Isomorphisms - Group actions.

Subgroups: Definition and Examples - Centralizers and Normalizers, Stabilizers and Kernels.

Unit-2: Subgroups (Continued):

Cyclic groups and Cyclic subgroups of a group.

Quotient Groups and Homomorphisms: Definitions and Examples - More on cosets and Lagrange's Theorem - The isomorphism theorems - Transpositions and the Alternating group.

Unit-3: Group Actions:

Group actions and permutation representations - Groups acting on themselves by left multiplication - Cayley's theorem - Groups acting on themselves by conjugation - The class equation - Automorphisms.

Unit-4: Group Actions (Continued):

The Sylow theorems - The simplicity of An.

Further topics in group theory: p-groups, Nilpotent groups and Solvable groups.

Unit-5: Direct and semi-direct products and abelian groups:

Direct Products - The fundamental theorem of finitely generated abelian groups - Table of groups of small order - semi direct products.

Text Book:

1. David S. Dummit and Richard M. Foote, (2004),*Abstract Algebra,* Third Edition, Wiley Student Edition, ISBN 0-471-4334-9.

   Unit I: Chapter 1: (Sections 1.2, 1.3. 1.4, 1.6, 1.7) and

   Chapter 2: (Sections 2.1, 2.2)

   Unit II: Chapter 2: (Section 2.3) and

   Chapter 3: (Sections 3.1, 3.2, 3.3, 3.5)

   Unit III: Chapter 4: (Sections 4.1, 4.2, 4.3, 4.4)

   Unit IV: Chapter 4: (Sections 4.5, 4.6) and

   Chapter 6: (Section 6.1)

   Unit V: Chapter 5: (Sections 5.1, 5.2, 5.3, 5.5)

Supplementary Reading:

1. Herstein I.N., (2007), *Topics in Algebra,* Second Edition, John Wiley & Sons, New Delhi, Third Reprint.
2. Jacobson N. and Van D., (1951), *Lectures in Abstract Algebra*, Nostrand Co., Vol. I, New York.
3. Anderson M. and Feil T., (2005), *A First Course in Abstract Algebra – Rings, Groups, and Fields*, Chapman & Hall/CRC.
4. Artin M., (2015), *Algebra*, Prentice Hall of India, New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC102: Advanced Real Analysis	L	T	P	C
I		5	0	0	5

Learning Objective (LO):

LO1	The concept of derivatives of real valued functions and their properties are studied.
LO2	Properties of monotonic functions, functions of bounded variations are also introduced.
LO3	The concept of Riemann-Stieltjes integral and its properties are studied.
LO4	The notion of convergence and uniform convergence of real valued functions and infinite series of functions are also studied.

Course Outcomes (CO)

At the end of the course, the student will be able to introduced to and have knowledge of many mathematical concepts

CO1	of proof techniques
CO2	of problem solving
CO3	studied in real analysis such as • Functions of bounded variations, • Riemann –Stieltjes Integral, • Sequence of functions, • Multivariate Differential Calculus.

Unit-1:Functions of Bounded Variation:

Properties of monotonic functions, Functions of bounded variation, Total variation, Additive property of total variation, Total variation on [a, x] as a function of x, Functions of bounded variation expressed as the difference of increasing functions, Continuous functions of bounded variation.

Riemann-Stieltjes Integral: The definition of the Riemann-Stieltjes integral, Linear properties, Integration by parts.

Unit-2:Riemann-Stieltjes Integral (Continued) :

Change of variable in a Riemann-Stieltjes integral, Reduction to a Riemann integral, Step functions as integrators, Reduction of a Riemann-Stieljes integral to a finite sum, Euler's summation formula, Monotonically increasing integrators, Upper and lower integrals, Additive and linearity properties of upper and lower integrals, Reimann's condition, Comparison theorems, Integrators of bounded variation.

Unit–3:Riemann-Stieltjes Integral (Continued):

Sufficient conditions for existence of Riemann-Stieltjes integrals, Necessary conditions for existence of Riemann-Stieltjes integrals, Mean value theorems for Riemann-Stieltjes integrals, The integral as a function of the interval, Second fundamental theorem of integral calculus, Change of variable in a Riemann integral, Second mean-value theorem for Riemann integrals, Riemann-Stieltjes integrals depending on a parameter, Differentiation under the integral sign, Interchanging the order of integration.

Unit–4:Sequence of functions:

The Taylor's series generated by a function, Bernstein's theorem, Abel's limit theorem, Tauber's theorem.

Multivariable differential calculus: The directional derivative, directional derivatives and continuity, the total derivative, the total derivative expressed in terms of partial derivatives.

Unit–5:Multivariable differential calculus (Continued):

The Jacobian matrix.

Implicit functions: Functions with non-zero Jacobian determinant, the inverse function theorem, the implicit function theorem.

Text Book:

Tom. M. Apostol, (1974), *Mathematical Analysis*, Second Edition, Narosa Publishing House, New Delhi.

Unit – I Chapter 6 Sections 6.1 to 6.8;

Chapter 7 Sections 7.1 to 7.5;

Unit – II Chapter 7 Sections 7.6 to 7.15;

Unit – III Chapter 7 Sections 7.16 to 7.25;

Unit – IV Chapter 9 Sections 9.19; 9.20, 9.22, and 9.23;

Chapter 12 Sections 12.1 to 12.5;

Unit – V Chapter 12: Section 12.8;

Chapter 13 Sections 13.1 to 13.4.

Unit – VI Chapter 14 Sections 14.1 to 14.3

Supplementary Reading:

1. Walter Rudin, (2013), *Principles of Mathematical Analysis*, McGraw-Hill International Book Company, New Delhi.
2. Malik S.C and Arora, S., (1991), *Mathematical Analysis*, Wiley Eastern Ltd., New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO 8	PO9	PO1 0	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC103: Advanced Differential Equations	L	T	P	C
I		5	0	0	5

Learning Objective (LO):

LO1	This Course aims to provide problem solving techniques in ordinary differential equations with variable coefficients and some special partial differential equations of Mathematical Physics such as Elliptic and Parabolic equations.

Course Outcomes (CO)

On successful completion of the course, the student will be able to:

CO1	Apply the fundamental concept of ordinary and partial differential equation to demonstrate their understanding of how physical phenomena are modelled by second order differential equations and dynamical systems; and perform operations with Bessel, Hermite and Legendre differential equations along with the corresponding recurrence formulas of different functions.
CO2	Solve various first order and higher orders differential equations with their applications.
CO3	Illustrate the mathematical aspects that contribute to the solution of heat, wave and diffusion equations.

Unit-1: Linear Equation with Variable Coefficients

Initial value problems - Existence and uniqueness theorems - Solutions to solve a non-homogeneous equation - Wronskian and linear dependence - reduction of the order of a homogeneous equation - homogeneous equation with analytic coefficients -The Legendre equation.

Unit-2: Linear Equation with Regular Singular Points

Euler equation - Second order equations with regular singular points - Exceptional cases - Bessel Equation.

Unit-3: Existence and Uniqueness of Solutions to First Order Equations

Equation with variable separated - Exact equations - method of successive approximations - the Lipschitz condition - convergence of the successive approximations and the existence theorem.

Unit-4: Elliptic Differential Equations

Derivation of Laplace and Poisson equation - BVP - Separation of Variables - Dirichlet Problem and Newmann Problem for a rectangle - Interior and Exterior Dirichlet problems for a circle - Interior Newmann problem for a circle - Solution of Laplace equation in Cylindrical and spherical coordinates - Examples.

Unit-5: Parabolic Differential Equations

Formation and solution of Diffusion equation - Dirac-Delta function - Separation of variables method - Solution of Diffusion Equation in Cylindrical and spherical coordinates - Examples.

Text Books:

1. Coddington E.A.,(1987) *An Introduction to Ordinary Differential Equations*, Prentice Hall of India, New Delhi.

Unit-I Chapter 3: Sections 1 to 8 [Omit Section 9]

Unit-II Chapter 4: Sections 1 to 4 and 6 to 8 [Omit Sections 5 and 9]

Unit-III Chapter 5: Sections 1 to 6 [Omit Sections 7 to 9]

Unit – VI Chapter 6: Sections 2 and 3

2. Sankar Rao S., (2005), *Introduction to Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi,.

   Unit-IV Chapter 2: Sections 2.1, 2 2, 2.5 to 2.13 (omit Sections 2.3 and 2.4)

   Unit-V Chapter 3: Sections 3.1 to 3.7 and 3.9 (omit Section 3.8)

   Unit – VI Chapter 4: Sections 4.1 to 4.3

Supplementary Reading:

1. George F. Simmons, (2004),*Differential equations with applications and historical notes*, Second Edition, Tata McGraw Hill Publishing Company, New Delhi.
2. Hildebrand, F.B., (1976) *Advanced calculus for applications*, Prentice - Hall. Inc.
3. SneddonI.N., (2006), *Elements of Partial Differential Equations*, McGraw Hill, New Delhi.
4. Raisinghania, M.D., (2001), *Advanced Differential Equations*, S.Chand & Company Ltd., New Delhi.
5. King A.C., Billingham J. and Otto S.R., (2006), *Differential Equations*, Cambridge University Press.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC104: Differential Geometry	L	T	P	C
I		5	0	0	5

Learning Objective (LO):

LO1	To introduce space curves, surfaces, curves on surfaces and study some of their properties.
LO2	To study the notion of geodesic and its properties.
LO3	To understand some type of special surfaces such as developables and minimal surfaces.

Course Outcomes (CO)

After successful completion of the course the student will be able to:

CO1	understand the concept of a space curve in 3D and compute the curvature and torsion of space curves;
CO2	understand the fundamental existence theorem for space curves;
CO3	find geodesics equations on a surface;
CO4	understand surfaces of constant curvature (Minding's theorem) and Gaussian curvature;
CO5	determine the second fundamental form and developables associated with space curves.

Unit–1: Space curves

Space curves, Arc length, Tangent, normal and binormal, Curvature and torsion of a curve given as the intersection of two surfaces.

Unit–2: Space curves (continued)

Contact between curves and surfaces, Tangent surface, involutes and evolutes, Intrinsic equations, Fundamental existence theorem for space curves, Helices.

Unit–3: Metric

Surface, Curves on a surface, Metric, Direction coefficients, Geodesics, Canonical geodesic equations, Normal property of geodesics, Geodesic curvature.

Unit–4: Metric (continued)

Gauss-Bonnet theorem, Gaussian curvature, Surfaces of constant curvature, Conformal mapping, Only statements of Dini's theorem and Tissot's theorem.

Unit–5: Second Fundamental form

Second fundamental form, Developables, Developables associated with space curves, Developables associated with curves on surfaces, Minimal surfaces.

Text Book:

1. Willmore, T.J., (1959), *An Introduction to Differential Geometry*, Oxford University Press, New Delhi.

   Unit-I Chapter 1 Sections 1 to 5

   Unit-II Chapter 1 Sections 6 to 9

   Unit-III Chapter 2 Sections 1, 2, 5, 6, 10, 11, 12 and 15

   Unit-IV Chapter 2 Sections 16 to 20

   Unit-V Chapter 3 Sections 1, 4, 5, 6, 7.

Supplementary Reading:

1. Struik, D.T., (1950), *Lectures on Classical Differential Geometry*, Addison-Wesley Press.
2. Andrew Pressley, (2001), *Elementary Differential Geometry*, Springer.
3. Heinrich, W. Guggenheimer, (1977), *Differential Geometry*, Dover publications, Inc., New York.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3
CO4	3	3	3	3						3	3	3	3	3
CO5	3	3	3	3						3	3	3	3	3

Semester	19MATC201: Advanced Abstract Algebra – II	L	T	P	C
II		5	0	0	5

Learning Objective (LO):

LO1	This course aims to provide a continuation of Advanced Abstract Algebra-I.
LO2	The focus of the course will be the study of Rings, Polynomial rings, Euclidean ring, Unique factorization domains, Module Theory, Field theory and Splitting fields..

Course Outcomes (CO)

Students will be introduced to and have knowledge of many mathematical concepts of

CO1	abstract structures
CO2	proof techniques
CO3	problem solving studied in Abstract Algebra such as • Rings, • Irreducibility, • Modules, a generalization of vector spaces, • Fields.

Unit-1: Introduction to Rings:

Examples: Polynomial rings - Matrix rings and group rings - Ring Homomorphisms and quotient rings - Properties of Ideals - Rings of fractions - The Chinese remainder theorem.

Unit-2: Rings (continued):

Euclidean domains, principal ideal domains and unique factorization domains.

Polynomial rings: Definitions and basic properties – Polynomial rings over fields.

Unit-3: Polynomial rings (continued):

Polynomial rings that are unique factorization domains – Irreducibility criteria – Polynomial ring over fields. Introduction to Module Theory: Basics definitions and examples – Quotient modules and Module homomorphism.

Unit-4: Field theory:

Basic Theory of field extensions - Algebraic Extensions.

Unit-5: Field theory (continued):

Splitting fields and Algebraic closures - Separable and inseparable extensions - Cyclotomic polynomials and extensions.

Text Book:

1. David S. Dummit and Richard M. Foote, (2004), *Abstract Algebra*, Third Edition,Wiley Student Edition.

   Unit I: Chapter 7: (Sections 7.2,7.3,7.4,7.5,7.6)

   Unit II: Chapter 8: (Sections 8.1,8.2,8.3) and

   Chapter 9: (Sections 9.1,9.2)

   Unit III: Chapter 9: (Sections 9.3,9.4,9.5),

   Chapter 10: (Sections 10.1,10.2)

   Unit IV: Chapter 13: (Sections 13.1,13.2)

   Unit V: Chapter 13: (Sections 13.4,13.5,13.6)

Supplementary Reading:

1. HersteinI.N., (2007), *Topics in Algebra,*Second Edition,John Wiley & Sons, New Delhi, Third Reprint.
2. Jacobson N. and Van D.,(1951), *Lectures in Abstract Algebra*, Nostrand Co., Vol. I, New York.
3. Anderson,M. and Feil T., (2005), *A First Course in Abstract Algebra – Rings, Groups, and Fields*, Chapman &Hall/CRC,.
4. Artin, M., (2015), *Algebra*, Prentice Hall of India, New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC202: Measure Theory and Integration	L	T	P	C
II		5	0	0	5

Learning Objective (LO):

LO1	The concept of Lebesgue measure is introduced.
LO2	Measure space and integration with respect to a measure are introduced
LO3	Convergence in measure and properties of L^p space are discussed.

Course Outcomes (CO)

Students will be introduced to and have knowledge of many mathematical concepts of

CO1	measures and spaces
CO2	proof techniques
CO3	problem solving studied in Measure theory & Integration such as • Measurable sets and Measurable functions, • Integration with respect to Measure, • Convergence in Measure.

Unit-1:

Lebesgue Outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability.

Unit-2:

Integration of nonnegative functions, General integral, Integration of series, Riemann and Lebesgue integrals.

Unit-3:

Continuous non-differentiable functions, Lebesgue differential theorem (statement only), Differentiation and Integration, Lebesgue set, Convergence in measure, Almost uniform convergence.

Unit–4:

Measures and outer measures, Extension of a measure, Uniqueness of the extension, Completion of a measure, Measure spaces, Integration with respect to a measure.

Unit-5:

G^G spaces, Convex functions, Jensen's inequality, The inequalities of Holder and Minkowski, Completeness of G^G (μ).

Text Book:

1. G. de Barra, (2005), *Measure Theory and Integration*, New Age International Publishers,Chennai.

   Unit – I Chapter 2: Sections 2.1 to 2.5

   Unit – II Chapter 3: Sections 3.1 to 3.4

   Unit – III Chapter 4: Sections 4.2, 4.4 to 4.6 and

   Chapter 7: Sections 7.1,7.2

   Unit – IV Chapter 5: Sections 5.1 to 5.6

   Unit – V Chapter 6: Sections 6.1 to 6.5.

   Unit – VI Chapter 7: Sections 7.1 to 7.3

Supplementary Reading:

1. Royden, (1968), *Real Analysis*, MacMillan Publishing Company, New York.
2. Ganapathy Iyer, V., (1977), *Mathematical Analysis*, Tata McGraw Hill Publication Co. Ltd., New Delhi.
3. Halmos, P.R., (1950), *Measure Theory*, Van Nostr and Princeton, New Jersey.
4. Michael E. Taylor, (2006), *Measure Theory and Integration by Graduate Studies in Mathematics*, Indian Edition, Volume 76, American Mathematical Society.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC203: Advanced Complex Analysis	L	T	P	C
II		5	0	0	5

Learning Objective (LO):

LO1	This course aims to train the students to get essential knowledge in functions of a complex variable.
LO2	Analytic functions and their properties, Residue theorem and its applications, Riemann mapping theorem are discussed in detail.

Course Outcomes (CO)

After successful completion of the course the student will be able to

CO1	use Cauchy's integral theorem or formula to compute complex line integrals;
CO2	compute the Taylor's theorem, to determine the nature of the removable singularities;
CO3	explain the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain;
CO4	determine the concept of conformal mapping of polygons, to find Schwarz – Christoffel formula.

Unit–1:Complex integration:

Line integrals, Rectifiable arcs, Line integrals as functions of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem in a Disc.

Cauchy's integral Formula:

The index of a point with respect to a closed curve, The integral formula, Higher derivatives.

Unit–2:Local Properties of Analytic Functions:

Removable Singularities, Taylor's theorem, Zeros and poles, The Local Mapping and The Maximum Principle.

The General Form of Cauchy's Theorem:

Chains and cycles, Simple connectivity, Locally exact differentials, Multiply connected regions.

Unit–3:Harmonic Functions:

Definition and basic properties, The mean-value property, Poisson's Formula, Schwarz's theorem, The Reflection principle.Power Series Expansions:Weierstrass's Theorem, The Taylor series, The Laurent Series.

Unit–4:Partial Fractions and Factorization:

Partial fractions, Infinite products and Canonical products. Normal Families: Equicontinuity, Normality and Compactness, Arzela's Theorem, Families of Analytic Functions, The classical definition.

Unit–5:The Riemann Mapping Theorem:

Statement and Proof Conformal mapping of Polygons: The behaviour at an angle, The Schwarz-Christoffel formula, Mapping on a rectangle, The triangle functions of Schwarz. A Closer look at Harmonic Functions: Functions with the Mean-value Property, Harmack's Principle.

Text Book:

1. AhlforsL.V., (2014), *Complex Analysis*, Third Edition, McGraw Hill Inc., New Delhi.

   Unit-I Chapter 4 Sections 1 & 2.

   Unit-II Chapter 4 Sections 3, 4 (4.1, 4.2, 4.6 and 4.7 only).

   Unit-III Chapter 4 Section 6; Chapter 5 Section 1.

   Unit-IV Chapter 5 Section 2 (2.1, 2.2 and 2.3 only).

   Chapter 5 Section 5.

   Unit-V Chapter 6 Sections 1 (1.1 only), 2 and 3.

Supplementary Reading:

1. ConwayJ.B., (1973), *Functions of One Complex Variable,* Springer-Verlag.
2. SilvermanH., (1975), *Complex Variables*, Hughton Miffin Company.
3. PonnusamyS., (2005), *Foundations of Complex Analysis*, Second Edition, Narosa Publishing House, New Delhi.
4. James Ward Brown and Ruel V. Churchill, (2014), *Complex Variables and Applications*, McGraw Hill Education (India), New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3
CO4	3	3	3	3						3	3	3	3	3

Semester	19MATP204: C++ Computer Practical	L	T	P	C
II		0	0	4	2

Learning Objective (LO):

LO1 The objective are acquire the practical knowledge to solve problems including the fields of optimization, number theory and matrix theory.

Course Outcomes (CO)

By the end of the course,

CO1 the students will be able to gain knowledge between theory and practical.

1. Solution of Linear Programming Problem.

2. Deterministic Inventory Models.

i. Single-item Static Model.

ii. Single-item Static Model with Price Breaks.

iii. Multi-item Static Model with Storage Limitation.

3. Number Theory:

i. Reversing of an integer series.

ii. Generating Fibonocci series.

iii. Average and Standard Deviation of numbers.

iv. Identification of Prime, Even and Odd integers.

4. Matrix Theory

i. Determinant of a matrix.

ii. Rank of a matrix.

iii. Inverse of a matrix.

iv. Product of matrices.

Text Books:

1. Hamdy A. TAHA, (2014), *Operations Research – An Introduction*, Macmillan Publishing Company, New York.

2. Ivan Niven, Herbert S.Zuckerman and Hugh L. Montgomery, (2015), *An Introduction to the theory of Numbers*, Wiley, New Delhi.
3. Grewal, B.S.,(2014)*Higher Engineering Mathematics*, 40th Edition, Khanna Publications, New Delhi,

.**Supplementary Reading:**

1. Premkumar Gupta and D.S.Hira S.Chand, (2016), *Operations Research*, New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2				3	2	3	2	3

Semester	19MATC301: Topology	L	T	P	C
III		5	0	0	5

Learning Objective (LO):

LO1	The idea and method of topology have transformed large parts of geometry and analysis.
LO2	This subject is of interest in its own right, and it also serves to lay the foundations for future studies in analysis and geometry.
LO3	In this course we teach the basics of topology including connectedness, compactness, countability, separation axioms, Tychonoff theorem and complete metric spaces.

Course Outcomes (CO)

Students will be introduced to and have knowledge of many mathematical concepts of,

CO1	spaces
CO2	proof techniques
CO3	problem solving studied in Topology such as • Connectedness • Compactness • Completeness which are studied in Real Numbers.

Unit-1:

Topological spaces, Basis for a topology, The order topology, The product topology on $X \times Y$.

Unit-2:

The subspace topology, Closed sets and limit points, Continuous function, The product topology.

The metric topology, Connected spaces, Connected subspaces of the real line, Components and Local connectedness.

Unit-3:

Compact spaces, Compact subspaces of the real line, Limit point compactness, Local compactness.

Unit-4:

Countability axioms, The separation axioms, Normal spaces, Urysohn Lemma, Urysohn metrization theorem, Tietze extension theorem.

Unit-5:

The Tychonoff Theorem, Stone-Cech compactification, Complete metric spaces, Compactness in metric spaces.

Text Book:

1. James R. Munkres, (2000), *Topology*, Second Edition, Prentice Hall of India, New Delhi.

Unit – I	Chapter 2: Sections 12 to 15.
Unit – II	Chapter 2: Sections 16 to 21 and
	Chapter 3: Sections 23 to 25.
Unit - III	Chapter 3: Sections 26 to 29.
Unit - IV	Chapter 4: Sections 30 to 35.
Unit - V	Chapter 5: Sections 37 and 38;
	Chapter 7: Sections 43 and 45 only.
Unit - VI	Chapter 4: Sections 36
	Chapter 6: Sections 41

Supplementary Reading:

1. Hu, S.T., (1964), *Elements of General topology*, Holden-Day Inc, San Francisco.
2. Hocking, J.G. and Young,G.S., (1961), *Topology*, Addison-Wesley Pub. Com.

3. Simmons, G.F., (1963), *Introduction to Topology and Modern Analysis*, McGraw Hill International Edition, Singapore.
4. Kumaresan ,S., (2005), *Topology of Metric Spaces*, Narosa Publishing House, New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	**19MATC302: Linear Algebra**	**L**	**T**	**P**	**C**
III		**5**	**0**	**0**	**5**

Learning Objective (LO):

LO1	This course aims learning the students to solve systems of linear equations using multiple methods, echelon Matrices, matrix operations, including inverses and invertible matrix using determinants.
LO2	Applying principles of matrix algebra to linear transformations, double dual, commutative rings, Characteristic values, Annihilating polynomials and Decompositions of Invariant Direct sums are studied.

Course Outcomes (CO)

Students will be introduced to and have the knowledge of many mathematical concepts of

CO1	transformations
CO2	proof techniques
CO3	problem solving in (studied in Linear Algebra such as) • Systems of linear Equations, • The algebra of linear transformations, • Determinant functions, • Diagonalization, • Decompositions.

Unit-1: Linear Equations and Vector spaces

Systems of linear Equations – Matrices and Elementary Row operations – Row-Reduced echelon Matrices – Matrix Multiplication – Invertible Matrices - Vector spaces – Subspaces – Bases and Dimension – Computations concerning Subspaces.

Unit-2: Linear Transformations

The algebra of linear transformations – Isomorphism of Vector Spaces – Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual – The Transpose of a Linear Transformation.

Unit-3: Determinants

Commutative rings – Determinant functions – Permutations and the uniqueness of determinants – Classical Adjoint of a (Square) matrix – Inverse of an invertible matrix using determinants.

Unit-4: Canonical Forms

Characteristic values – Annihilating polynomials, Invariant subspaces.

Unit-5: Canonical Forms (continued)

Simultaneous triangulation and simultaneous Diagonalization – Direct-sum Decompositions - Invariant Direct sums – The Primary Decomposition Theorem.

Text Book:

1. Kenneth Hoffman and Ray Kunze, (1971) *Linear Algebra*, Second Edition, Prentice – Hall of India Private Limited, New Delhi.

   Chapters 1 to 3, Chapter 5 (5.1 to 5.4) and Chapter 6.

Supplementary Reading:

1. HersteinI.N., (2007) *Topics in Algebra,* , Second Edition Third Reprint, John Wiley & Sons, New Delh.,
2. Rao,A.R. and Bhimasankaram, P. (2000). *Linear Algebra*, Second Edition, TRIM series 19, Hindustan Book Agency. New Delhi.
3. Charles W. Curtis, (1984). *Linear Algebra – An Introductory Approach,* Springer.
4. Keith Nicholson, W. (2006). *Linear Algebra with Applications*, Fifth Edition, Mc Graw Hill.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC303: Probability Theory	L	T	P	C
III		5	0	0	5

Learning Objective (LO):

LO1 The objective are

(i) acquire quantative skills and an understanding of rigorous concepts and methods in probability theory through measure theoretic approach

(ii) acquire understanding of diverse characteristics like convergence, law of large numbers and central limit theorems.

(iii) Acquire the ability to solve widely varied problems.

Course Outcomes (CO)

By the end of the course, students will be able to gain

CO1	knowledge related to probability problems
CO2	a basic knowledge for studying advanced courses in this area like stochastic processes.

Unit-1: **Distribution Function:**

Monotone functions, Distribution functions, Absolutely continuous and Singular distributions.

Measure Theory:

Classes of sets, Probability measures and their distribution functions.

Random variable, Expectation, Independence:

General definitions, Properties of mathematical expectation, Independence.

Unit-2: **Convergence Concepts:**

Various modes of convergence, Almost sure Convergence; Borel-Cantelli lemma, Vague Convergence, Continuation.

Unit-3:Law of Large Numbers. Random series:

Simple limit theorems, Weak law of large numbers, Convergence of series, Strong law of large numbers.

Unit-4:Characteristic Function:

General properties; Convolutions, Uniqueness and inversion, Convergence theorems, Simple applications.

Unit-5:Central limit theorem and its Ramifications:

Liapounov's theorem, Lindeberg-Feller theorem, Ramification of the central limit theorem.

Text Book:

1. Chung,K.L., (1974). *A Course in Probability Theory*, Second Edition, Academic Press..

Unit - I	Chapter 1 (Sections 1 to 3).
	Chapter 2 (Sections 1 and 2).
	Chapter 3 (Sections 1 to 3).
Unit – II	Chapter 4 (Sections 1 to 4).
Unit - III	Chapter 5 (Sections 1 to 4).
Unit – IV	Chapter 6 (Sections 1 to 4).
Unit - V	Chapter 7 (Sections 1 to 3).

Supplementary Reading:

1. Bhat, B.R., (2018) *Modern Probability Theory*, New Academic Science, UK.
2. Sheldon M. Ross, (2010). *A first Course in probability*, Eight Edition Pearson Education Ltd, London..
3. Burril, C.W., (1972) *Measure, Integration and Probability*, McGraw Hill, New York.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3

Semester	19MATP304: Numerical Methods Practical (Using C++ language)	L	T	P	C
III		0	0	4	2

Learning Objective (LO):

LO1 The objectives are acquire the practical applicability of C++ Programming to some of the problems in numerical mathematics.

Course Outcomes (CO)

By the end of the course:

CO1 students will be able to gain knowledge between theory and practical.

1. Solution of transcendental and polynomial equations in one variable:
    i. Method of Bisection
    ii. Method of Regula Falsi
    iii. Newton's Method
2. Solution of Linear Equations:
    i. Jacobi's Iterative Method
    ii. Gauss-Seidal Iterative Method
3. Numerical Solution of Ordinary Differential Equations:
    i. Euler's Method.
    ii. Modified Euler's Method
    iii. Runge-Kutta Method of order four

4. Numerical Integration:

i. Simpson's one third rule

ii. Simpson's three eighth rule

iii. Weddle's rule.

Text Book:

1. Krishnamoorthy, E.V. and Sen, S.K., (1996) *Numerical Algorithms*, Second Edition Affiliated East West Press Pvt. Ltd.,.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	2	3				2	3	2	3	3

Semester	19PSCI306: CONSTITUTION OF INDIA	L	T	P	C
III		2	0	0	2

Learning Objective (LO):

LO1	To understand the basic features of Indian Constitution.
LO2	To grasp about the basic Rights & duties of Indian Citizenry
LO3	To ponder over the form of Indian Political System.
LO4	To have broad understanding about the pivotal provisions related with liberty, Equality and fraternity.

Course Outcomes (CO)

Students will be introduced to and have the knowledge of many mathematical concepts of

CO1	Imbibed about the basic features of Indian Political System.
CO2	Enlighten with the rights & duties of Indian Citizens.
CO3	Understand the significance of rule of law.
CO4	Inculcated with basic liberties.

Unit I : Introduction

Meaning of the Constructional law and Constitutionalism – Historical Perspective of the Constitution of India – Salient features Characteristics of the Constitution of India

.**Unit II : Rights and Duties**

Scheme of the Fundamental Rights – The scheme of the Fundamental Duties and its legal status – The Directive Principles of State Policy-Its importance and implementation

Unit III : Centre State Relationship

Federal Structure and distribution of legislative and financial powers between the union and the states- Parliamentary form of Government in India – The Constitution powers and status of the president of India.

Unit IV : Amendments and Provisions

The Historical perspectives of the constitutional amendments in India – Emergency Provision: National Emergency, President Rule. Financial Emergency

Unit V: Institutions

Judiciary –Judiciary Activism – Amending Procedures- Recent Trends –Rights to Information- Lokpal and LokAyukta

Text Books :

1. Bipan Chandra, Mridula Mukherjee, Adility Makherjee (2016), India after Independence 1947-2000, Penguin Publishers, New Delhi.
2. Durga Das Basu,(2018), Introduction to the Constitution of India Prentice Hall, New Delhi.
3. .Jogendra Yadav (2000), Transforming India: Dynamics of Democracy, Oxford University Press New Delhi

Supplementary Readings:

1. The Constitution of India (1950) Bare Act, Government Publications.
2. Busi S.N. and Ambedkar B.R,(2015) Framing of Indian Constitution
3. Jain M..P., (2014), Indian Constitution Law, Lexis Nexis.
4. Paul R.Brass,(1999), The politics of India Since Independence Cambridge University Press

5. Granvila Austin, (2006), The Indian Constitution: Cornerstone of a Nation, Oxford University Press, New Delhi

Outcome Mapping:

CO/PO	PO												PSO				
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
CO1		3	3		2					2			3	3			
CO2		3	2		3	2							3			3	2
CO3	3	2		3	2					2					3	2	2

Semester	19MATC401: Functional Analysis	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1	There are many domains in the broad field of topology.
LO2	The following are the few viz, the theory of Banach and Hilbert Spaces and their operators and Banach algebras.
LO3	In this course we teach some results on Banach spaces, Hilbert spaces, operator theory and Banach algebras.
LO4	Each of these subjects starts from the fundamental knowledge and develops its own methods of dealing with its own characteristic problems.

Course Outcomes (CO)

In the board field of topology, students gain knowledge related to

CO1	examples and counter examples to the corresponding theory
CO2	proof techniques
CO3	problem solving in Banach space, Hilbert space and spectral operator theory.

Unit–1: Linear transformations and Banach spaces

Linear transformations, Banach spaces, Continuous linear transformations, The Hahn-Banach theorem.

Unit–2: Banach spaces (continued)

The natural embedding of N into N**, The open mapping theorem, The conjugate of an operator.

Unit–3: Hilbert spaces

Hilbert space, Orthogonal complements, Orthonormal sets, The Conjugate space H*, The adjoint of an operator, Self adjoint operators, Normal and Unitary operators.

Unit–4: Finite dimensional Spectral theory

Matrices, Determinants and Spectrum of an operator, The spectral theorem.

Unit–5: Banach algebras

Definition and some examples, Regular and singular elements, Topological divisors of zero, The spectrum, The formula for the spectral radius.

Text Book:

1. Simmons, G.F., (2015) *Introduction to Topology and Modern Analysis*, McGraw Hall Book Company, New Delhi.

   Unit-I Chapter 8: Section 44 only and

   Chapter 9: Sections 46, 47 and 48.

   Unit-II Chapter 9: Sections 49, 50 and 51.

   Unit-III Chapter 10: Sections 52 to 58.

   Unit-IV Chapter 11: Sections 60, 61 and 62.

   Unit-V Chapter 12: Sections 64 to 68.

   Unit-VI Appendices 1,3

Supplementary Reading:

1. Limaye, B.V.(1996),*Functional Analysis*, Prentice - Hall of India, New Delhi.
2. Bachmann and Narishi,(2000) *Functional Analysis*, Academic Press, Cambridge.
3. Karen Saxe, (2002) *Beginning Functional Analysis*, Springer.
4. Goffman, C. and Padrick, G.(1974) *A First Course in Functional Analysis,* Chelsea Publishing Company, New York.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	19MATC402: Stochastic Processes	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1 The objectives are to

(i) acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge.

(ii) acquire understanding of applicability of different concepts of stochastic processes on some physical situation.

(iii) to familiarize the students with the use of stochastic models in different areas.

Course Outcomes (CO)

By the end of the course, students will be able to gain

CO1	working knowledge related to the problems of uncertainty.
CO2	a basic knowledge for doing research in this area.

Unit-1: Stochastic Processes:

Introduction, Specification of Stochastic Processes, Stationary Process, Martingales.

Markov Chains:

Definition and Examples, Higher Transition Probabilities, Generalization of independent Bernoulli Trials: Sequence of Chain Dependent Trials, Classification of States and Chains.

Unit-2: More on Markov Chains:

Determination of Higher Transition Probabilities, Stability of a Markov System, Markov Chain with Denumerable Number of States, Reducible Chains.

Unit-3: **Markov Processes with Discrete State Space:** Poisson Process and its Extensions:

Poisson Process, Poisson Process and Related Distributions, Generalization of Poisson Process, Birth and Death Process, Markov Process with Discrete State Space (Continuous Time Markov Chains).

Unit-4: Markov Chains and Markov Processes with Continuous State Space:

Markov Chains with Continuous State Space, Introduction, Brownian Motion, Wiener Process, Differential Equations for a Wiener Process, Kolmogorov Equations, First Passage Time Distribution for Wiener Process.

Unit-5: Renewal Processes and Theory:

Renewal Process, Renewal Processes in Continuous Time, Renewal Equation, Stopping time: Wald's Equation, Renewal Theorems, Delayed and Equilibrium Renewal Processes.

Text Book:

1. Medhi.J., (1994) ,*Stochastic Processes*, Second Edition, New Age International (P) Limited, Publishers, New Delhi. .

   Unit-I Chapter 2: Sections 1 to 4 and

   Chapter 3: Sections 1 to 4.

   Unit-II Chapter 3: Sections 5,6,8 and 9.

   Unit-III Chapter 4: Sections 1 to 5.

   Unit-IV Chapter 3: Section 11

   Chapter 5: Sections 1 to 5.

   Unit-V Chapter 6: Sections 1 to 6.

   Unit-VI Chapter 10: Sections 1,2 and5.

Supplementary Reading:

1. Karlin S. and Taylor H.M., (2011) *A First Course in Stochastic Processes*, Second Edition, Academic Press ,New York.
2. Ross, S.M., (2008) *Stochastic Processes*, Second Edition, Wiley India Pvt., Ltd., New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3

Semester	19MATC403: Fluid Dynamics	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1	This course aims to discuss kinematics of fluids in motion, Equations of motion of a fluid, three dimensional flows, two dimensional flows and viscous flows.

Course Outcomes (CO)

On successful completion of the course, the student will be able to,

CO1	Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
CO2	Recognize these principles written in form of mathematical equations.
CO3	Apply dimensional analysis to predict physical parameters that influence the flow in fluid dynamics.

Unit-1:Kinematics of Fluids in Motion:

Real fluids and ideal fluids – Velocity of a fluid at a point stream lines – path lines – Steady and unsteady flows – Velocity potential – The velocity vector – Local and particle rates of changes – Equations of continuity – Examples.

Unit-2: Equation of Motion of a fluid:

Pressure at a point in a fluid at rest – Pressure at a point in a moving fluid – Condition at a boundary of two invicid immersible fluids. Euler's equation of motion – Discussion of the case of steady motion under conservative body forces.

Unit-3: Some three dimensional flows:

Introduction – Sources – Sinks and doublets – Images in rigid infinite plane – Axis symmetric flows – Stokes stream function.

Unit-4:Some two-dimensional flows:

Two dimensional flows – Meaning of two dimensional flow – Use of cylindrical polar co-ordinates – The stream function – Complex potential for two dimensional – Irrational incompressible flow – Complex velocity potential for standard two dimensional flows – Examples.

Unit-5:Viscous flows:

Viscous flows – Stress components in a real fluid –Relation between Cartesian components of stress – Translation motion of fluid elements – The rate of strain quadric and principle stresses – Further properties of the rate of strain quadric – Stress analysis in fluid motion – Relation between stress and rate of strain – The coefficients of viscosity and Laminar flow – The Navier – Stokes equations of motion of a viscous fluid.

Text Book:

1. Chorlton, F., (1985), *Fluid Dynamics*, CBS Publication, New Delhi.
   Unit – I Chapter 2: Sections 2.1 to 2.8
   Unit – II Chapter 3: Sections 3.1 to 3.7
   Unit – III Chapter 4: Sections 4.1 to 4.3 and 4.5
   Unit – IV Chapter 5: Sections 5.1 to 5.6
   Unit – V Chapter 8: Sections 8.1 to 8.9.
   Unit – VI Chapter 9: Sections 9.1 to 9.4

Supplementary Reading:

1. Batchaelor, G.K., (1994) *An Introduction to Fluid Mechanics*, Foundation Books, New Delhi.
2. Yuan, S.W., (1976) *Foundations of Fluid Mechanics*, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Rathy, R.K., (1976) *An Introduction to Fluid Dynamics*, IBH Publ. Comp. New Delhi.
4. Pijush K. Kundu, Ira M. Cohen and David R. Dowling, (2010) *Fluid Mechanics*, Fifth Edition, Academic Press, New York.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3

Semester	**19MATC404: Graph Theory**	**L**	**T**	**P**	**C**
IV		**4**	**0**	**0**	**4**

Learning Objective (LO):

LO1	Graph Theory is an integral part of Discrete Mathematics.
LO2	It has applications to many fields, including Computer Science, Physics, Chemistry, Psychology and Sociology.
LO3	In this course we teach basic topics in graph theory such as Trees, Connectivity, Euler tours, Hamilton cycles, Matchings, Colourings, Planar graphs.

Course Outcomes (CO)

Students will be introduced to and have knowledge of many mathematical concepts

CO1	to give examples and counter examples corresponding to the theory
CO2	proof techniques
CO3	problem solving
CO4	Applications studied in Graph Theory such as • Trees, • Connectivity, • Euler tours, • Hamilton cycles, • Matchings, • Colourings, • Planar graphs

Unit–1: Basic Concepts:

Graphs – Subgraphs – Degrees of vertices – Paths and connectedness – Automorphism of a simple graph, Line Graphs. Connectivity: Vertex cuts and Edge cuts – Connectivity and edge-connectivity, Blocks.

Unit–2: Trees:

Trees – Characterization and Simple properties. Independent sets and Matchings: Vertex Independent sets and Vertex Coverings – Edge-Independent Sets – Matchings and Factors, Matchings in Bipartite Graphs (except the proof of Tutte's 1-factor theorem).

Unit–3:

Eulerian Graphs. Hamiltonian Graphs.

Unit–4 :Graph Colorings:

Vertex Colorings – Critical Graphs – Brooks' Theorem.

Edge Colorings of Graphs – Vizing's Theorem – Chromatic Polynomials.

Unit–5: Planarity:

Planar and Nonplanar Graphs – Euler's Formula and its Consequences – G_G and $G_{G,G}$ are Nonplanar graphs – Dual of a Plane Graph – The Four Color Theorem and the Heawood Five-Color Theorem – Hamiltonian plane graphs.

Note: Theorems, Propositions and results which are starred are to be omitted.

Text Book:

1. Balakrishnan R. and Ranganathan K., (2012), , Second Edition, *A Textbook of Graph Theory*, Springer, New York.

   Unit - I Chapter 1: 1.1 to1.6; Chapter 3: 3.1 to 3.3;

   Unit - II Chapter 4: 4.1, 4.2; Chapter 5: 5.1 to 5.5;

   Unit - III Chapter 6: 6.2, 6.3;

   Unit - IV Chapter 7: 7.1, 7.2, 7.3 (except 7.3.2 and 7.3.3), 7.6, 7.9;

   Unit - V Chapter 8: 8.1 to 8.6; 8.8.

Supplementary Reading:

1. BondyJ, A. and Murty, U.S.R., (2008) *Graph Theory*, Springer.
2. Douglas B. West, (2011), *Introduction to Graph Theory*, PHI Learning Private Ltd, New Delhi.
2. Chartrand, G., Linda Lesniak and Ping Zhang, (2011), *Graphs and Digraphs*, Fifth Edition, CRC Press.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3
CO3	3	3	3	3						3	3	3	3	3
CO4	3	3	3	3						3	3	3	3	3

Semester	19MATC405: Calculus of Variations and Integral Equations	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1	The aim of the course is to introduce to the students the concept of calculus of variations and its applications.
LO2	Various types of integral equations have been introduced and method of solving these equations are given.

Course Outcomes (CO)

On Successful completion of the course student will be able to

CO1	Recognize the difference between Volterra & Fredholm integral equations, First kind & second kind, homogeneous and non-homogeneous etc.
CO2	understand the fundamental concepts related to the space of admissible variations and concepts of a weak and a strong relative minimum of an integral.

Unit-1:

Calculus of Variations and Applications:

Maxima and Minima - The Simplest case-Illustrative examples-Natural boundary conditions and transition conditions – The variational notation-The more general case.

Unit-2:

Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton's principle-Lagrange's equations.

Unit-3:

Integral Equations: Introduction – Relations between differential and integral equations – The Green's function – Alternative definition of the Green's function.

Unit-4:

Linear equation in cause and effect: The influence function – Fredholm equations with separable kernels – Illustrative example.

Unit-5:

Hilbert – Schmidt theory – Iterative methods for solving equations of the second kind – Fredholm theory.

Text Book:

1. Francis B. Hildebrand, *Methods of Applied Mathematics*, Second Edition.

   Unit I: Chapter 2: Sections 2.1 to 2.6

   Unit II: Chapter 2: Sections 2.7 to 2.11

   Unit III: Chapter 3: Sections3 .1 to 3.4

   Unit IV: Chapter 3: Sections3.5 to 3.7

   Unit V: Chapter 3: Sections3.8 to 3.9 and 3.11

Supplementary Reading:

1. Ram.,P. Kanwal, (1971) *Linear Integral Equations Theory and Practice*, Academic Press, New York.
2. ElsgoltsL.,2003) *Differential equations and the calculus of variations*, University Press of the Pacific, U.K.
3. Mikhlin, S.J, (1960) *Linear Integral Equations* (translated from Russian), Hindustan Book Agency, New Delhi.
3. SneddenI. N., (1966) *Mixed Boundary Value Problems in Potential Theory*, North Holland.
4. Lev D. Elsgole, (2007) *Calculus of Variations*, Dover Publications Inc, New York.
5. Rahman, M., (2007) *Integral Equations and their Applications*, WIT Press, Boston.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3						3	3	3	3	3
CO2	3	3	3	3						3	3	3	3	3

Elective Courses (DE):

Semester	19MATE205: Programming Language C++	L	T	P	C
II		3	0	0	3

Learning Objective (LO):

LO1	The language C++ is a Object Oriented Programming Language.
LO2	First the syntax of the language C++ is introduced.
LO3	This is followed by Control statement, Arrays, Functions, Pointers, Structures and Classes.
LO4	Many problems are solved after writing algorithms and programs in C++.

Course Outcomes (CO)

CO1	On Successful completion of C++ course, the students gathered computer knowledge in C++ to write programmes for various types of mathematical problems.

Unit-1: C++ Programming Basics:

Basic Program Construction: Functions, Program Statements, White Space. Output Using Cout: String Constants. Preprocessor Directives: The # include Directive, Header Files. Comments: Comment Syntax, When to Use Comments, Alternative Comment Syntax. Integer variables: Defining Integer Variables, Declarations and Definitions, Variable Names, Assignment Statement, Integer Constants, Output variations. Character Variables: Character Constants, Initialization, Escape Sequences. Input with Cin: Variables Defined at Point of Use, Cascading, Expressions, Precedence. Type float: Floating-Point Constants, The Const Qualifier, The # define Directive. Manipulators: The end L Manipulator, The set W Manipulator, Type Long, Cascading the Insertion Operator, Multiple definitions, The IOMANIP.H Header File. Variable Type Summary: Unsigned data types. Type Conversion: Automatic Conversions, Casts. Arithmetic operators: The Remainder Operator, Arithmetic Assignment operators, Increment Operators. Library Functions: Header Files, Library Files, Header Files and Library Files, Two Ways to Use # include.

Unit-2: Loops and Decisions:

Relational operators. Loops: The for Loop, Using Turbo C++ Debugging Features, for Loop Variations, The while Loop, Precedence: Arithmetic and Relational Operators, The do loop, When to Use Which Loop. Decisions: The if Statement, The if...else Statement, The else...if Construction, The Switch Statement. The Conditional Operator. Logical Operators: Logical OR

Operator, Logical AND Operator, The Logical NOT Operator, Precedence Summary, Other Control Statements, The break Statement, The continue Statement, The GOTO Statement.

Unit-3: Structures:

A simple structure, Specifying the structure, Defining a structure variable, Accessing structure members.

Functions:

Simple Functions: The Function Declaration, Calling the Function, The Function Definition, Comparison with Library Functions, Eliminating the Declaration. Passing Arguments to Functions: Passing Constants, Passing Variables, Passing by Value, Passing Structure Variables, Names in the Declaration. Returning Values from Functions: The return Statement, Returning structure Variables. Reference Arguments: Passing Simple Data Types by Reference. Overloaded Functions: Different Numbers of Arguments, Different Kinds of Arguments. Inline Functions: Default Arguments, Variables and Storage Classes: Automatic Variables, External Variables, Static Variables, Storage, Returning by Reference.

Unit-4: Arrays:

Array Fundamentals. Defining Arrays, Array Elements, Accessing Array Elements, Averaging Array Elements, Initializing Arrays, Multidimensional Arrays, Passing Arrays to Functions, Arrays of Structures. String: Variables, Avoiding Buffer Overflow, String Constants, Reading Embedded Blanks, Reading Multiple Lines,Copying a String the Hard Way, Copying a String the Easy Way, Arrays of Strings, Strings as Class Members, A User-Defined String Type.

Unit-5: Pointers:

Addresses and Pointers, The Address of Operator & Pointer Variables, Accessing the Variable Pointed To, Pointer to void. Pointers and Arrays: Pointer Constants and Pointer Variables. Pointers and Functions: Passing Simple Variables, Passing arrays, Sorting Array Elements. Pointers and Strings: Pointers to String Constants, Strings as Function Arguments, Copying a String Using Pointers, Library String Functions, Arrays of Pointers to Strings.

Text Book:

1. Robert Lafore, (1996),*Object-Oriented Programming in TURBO C++*, Galgotia Publications Pvt. Ltd., New Delhi.

   Unit-I Chapter 3

   Unit-II Chapter 4

   Unit-III Chapters 5 and 6

   Unit-IV Chapter 8

   Unit-V Chapter 12

Supplementary Reading:

1. Balagurusamy, E., (2006). *Programming in ANSI C*, Seventh Edition, Tata McGraw Hill Publishing Ltd., New Delhi.
2. Kanthane, A. N., (2006).*Object Oriented Programming in ANSI & Turbo C++,* Peason Education, New Delhi.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2	3	2				3	2	3	3	2

Semester	19MATE306: Number Theory	L	T	P	C
III		3	0	0	3

Learning Objective (LO):

LO1	The prime aim of this paper is to enrich the knowledge of Number Theory.
LO2	The concepts of primes, congruences, prime power moduli, power residues, quadratic residues, greatest integer function, Mobius inversion formula are introduced.
LO3	Diophantine equations and their positive solutions are discussed. Simple continued functions are also considered.

Course Outcomes (CO)

On successful completion of the course, the student will be able to understand the concepts

CO1	to give examples and counter examples corresponding theory
CO2	proof techniques
CO3	problem solving of • Divisibility relation, • Congruence relation, • Special number theoretic functions, • Diophantine equations and • Algebric numbers.

Unit-1: Divisibility and Congruences

Divisibility, Primes, Congruences, Solutions of Congruences, The Chinese Remainder Theorem.

Unit-2: Congruences (continued)

Prime power moduli, Prime modulus, Primitive Roots and Power Residues, Congruences of degree two, Prime Modulus.

Quadratic Reciprocity and Quadratic Forms:

Quadratic Residues, Quadratic reciprocity and the Jacobi symbol.

Unit-3: Some functions of Number Theory

Greatest integer function, Arithmetic functions, The Mobius inversion formula, Recurrence Functions, Combinatorial Number Theory.

Unit-4: Some Diophantine Equations

The equation ax+by=c, Simultaneous Linear Equations, Pythagorean Triangles, Assorted Examples, Ternary Quadratic Forms.

Unit-5: Simple Continued Fractions

The Euclidean Algorithm, Uniqueness, Infinite Continued Fractions, Irrational Numbers, Approximations to Irrational Numbers.

Text Book:

1. Ivan Niven, H.S. Zuckerman and Hugh L. Montgomery (1991). *An Introduction to the Theory of Numbers*, . Fifth Edition, Wiley Eastern Limited, New Delhi.

   Unit - I Chapter 1 Sections 1 to 3 and

   Chapter 2 Sections 1 to 3

   Unit – II Chapter 2 Sections 6 to 9 and

   Chapter 3 Sections 1 to 3

   Unit – III Chapter 4 Sections 1 to 5

   Unit - IV Chapter 5 Sections 1 to 5

   Unit - V Chapter 7 Sections 1 to 5

Supplementary Reading:

1. Tom M. Apostal, (2013). *Introduction to Analytic Number Theory*, Narosa Pub. Company, New Delhi.
2. Hsiung, C.Y., (1995) *Elementary Theory of Numbers*, World Scientific, Singapore.
3. Hardy, G.H. and Wright, E.M., (1989) *An Introduction to the Theory of Numbers*, . Fourth Edition, Clarendon Press, U.K.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2						3	2	3	2	3
CO2	3	2	3	2						3	2	3	2	3
CO3	3	2	3	2						3	2	3	2	3

Semester	19MATE307: Fuzzy Sets and their Applications	L	T	P	C
III		3	0	0	3

Learning Objective (LO):

LO1	This course aims to offer fuzzy sets, fuzzy relations, fuzzy logic, fuzzy composition and applications.

Course Outcomes (CO)

On successful completion of the course, the student will be able to identify the basic concepts

CO1	to give examples and counter examples corresponding theory
CO2	Proof techniques
CO3	problem solving on • characteristics of fuzzy logic, • α cuts, • operations on fuzzy sets, • extension principles, • fuzzy norms, • lattice of fuzzy numbers.

Unit-1:Fuzzy sets:

Fuzzy sets – Basic types – Basic concepts - Characteristics – Significance of the paradigm shift – Additional properties of α- Cuts.

Unit-2: Fuzzy Sets Versus CRISP Sets:

Representation of Fuzzy sets – Extension principle of Fuzzy sets – Operation on Fuzzy Sets – Types of Operation – Fuzzy complements.

Unit-3: **Operations on Fuzzy Sets:**

Fuzzy intersection – t-norms, Fuzzy unions – t conorms – Combinations of operations – Aggregation operations.

Unit-4: Fuzzy Arithmetic:

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Lattice of Fuzzy numbers.

Unit-5: Constructing Fuzzy Sets:

Methods of construction: An overview – Direct methods with one expert – Direct method with multiple experts – indirect method with multiple experts and one expert – Construction from sample data.

Text Book:

1. Klir G.J. and Bo Yuan, (2005), *Fuzzy Sets and fuzzy Logic: Theory and Applications*Prentice Hall of India Ltd., New Delhi.

Unit – I	Chapter 1: Sections 1.3 to 1.5 and
	Chapter 2: Sections 2.1
Unit – II	Chapter 2: Sections 2.2 to 2.3 and
	Chapter 3: Sections 3.1 to 3.2
Unit – III	Chapter 3: Sections 3.3 to 3.6
Unit – IV	Chapter 4: Sections 4.1 to 4.4
Unit – V	Chapter 10: Sections 10.1 to 10.7

Supplementary Reading:

1. Zimmermann, H.J., (1996). *Fuzzy Set Theory and its Applications*, Allied Publishers, Chennai.
2. Kaufman, A., (1975). *Introduction to the Theory of Fuzzy Subsets*, Academic Press, New York.
3. Novak, V., (1969). *Fuzzy Sets and Their Applications*, Adam Hilger, Bristol.

Outcome Mapping:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	2						3	2	3	2	3
CO2	3	2	3	2						3	2	3	2	3
CO3	3	2	3	2						3	2	3	2	3