Annamalai University

(Accredited with 'A' Grade by NAAC)

M.Sc. Mathematics (Five-Year) Programme

Regulations & Curriculum-2019

DST-FIST Assisted

Department of Mathematics

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE FIVE YEAR INTEGRATED POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Five Year Integrated Master's Programmes in the Faculties of Arts, Science, Languages, Marine Sciences, and Education from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 University refers to Annamalai University.

1.2 Department means any of the academic departments and academic centres 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/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/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 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 of 90 working days. Each academic year is divided into two semesters.

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 Experiential Learning is a process of learning through experience. It is specifically defined as "learning through reflection on doing".

1.15 Extension activities are the activities that provide a link between the University and the community such as lab-to-land, literacy, population education, and health awareness programmes. These are integrated within the curricula with a view to sensitise the students about Institutional Social Responsibility (ISR).

1.16 Credit refers to the quantum of course work in terms of the 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.

1.17 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.

1.18 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.

1.19 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.

1.20 Learning Objectives (also known as Course Objectives) are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

1.21 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.

1.22 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.

1.23 Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student in all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters.

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

2. Programmes Offered and Eligibility Criteria

The Department of Mathematics offers a Five Year M.Sc. Mathematics Programme.

Faculty of Science	
M.Sc. Mathematics	A pass in H.S.E. (10+2 level) OR Equivalent thereto with a minimum aggregate of 40% marks under academic stream in the following subjects viz. Mathematics, Physics & Chemistry.

2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for all the above Programmes.

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 Five Year Master's Programmes consist of five academic years and ten semesters.

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 Five Year Integrated Programme consists of Language Courses, Core Courses, Allied Courses, Elective Courses, Soft Skills, Experiential Learning and Project. Students shall also participate in Extension Activities as part of their curriculum.

5.2 Language Courses

5.2.1 Each student shall take two languages of four courses each, one in each semester for the first two years of the programme.

5.2.2 Language-I shall be Tamil or another language such as Hindi or French.

5.2.3 Language-II shall be English.

5.3 Core courses

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

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

5.4 Allied Courses

5.4.1 Each student shall take courses in two disciplines allied to the main subject (Allied-I and Allied-II) of the programme in the first four semesters.

5.4.2 In Arts, Languages, and Education, there will be three Theory Courses each for Allied-I and Allied-II.

5.4.3 In Science and Marine Sciences, there will be two Theory courses and one Practical course each for Allied-I and Allied-II.

5.5 Elective Courses

5.5.1 Departmental Electives (DEs) are the electives that students can choose from a range of Electives offered within the Parent Department offering the Programme.

5.5.2 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.

5.5.3 *Students shall take a combination of both DEs and IDEs.*

5.6 Soft Skills

5.6.1 Soft skills are intended to enable students to acquire attributes that enhance their performance and achieve their goals with complementing hard skills.

5.6.2 Soft skills include communication skills, computer skills, social skills, leadership traits, team work, development of emotional intelligence quotients, among others.

5.6.3 Each student shall choose four courses on soft skills from a range of courses offered from the First to the Sixth Semester.

5.7 Value Education

All students shall take a course on Value Education that includes human values, sustainable development, gender equity, ethics and human rights.

5.8 Experiential Learning

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

5.8.2 In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.9 Extension Activities

5.9.1 It is mandatory for every student to participate in extension activities.

5.9.2 All the students shall enrol under NSS/NCC/YRC/RRC or any other Service Organisation in the University.

5.9.3 Students shall put in a minimum attendance of 40 hours in a year duly certified by the Programme Co-ordinator.

5.9.4 Extension activities shall be conducted outside the class hours.

5.10 Project

5.10.1 Each student shall undertake a Project in the final semester.

5.10.2 The Head of the Department shall assign a Project Supervisor to the student.

5.10.3 The Project Supervisor shall assign a topic for the project and monitor the progress of the student periodically.

5.10.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Project Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.11 Value Added Courses (VACs)

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

5.11.2 VACs enhance the students' employability and life skills. VACs are listed on the University website and in the Handbook on Interdepartmental Electives and VACs.

5.11.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.11.4 Classes for VACs are conducted beyond the regular class hours and preferably in the VIII and IX Semesters.

5.12 Online Courses

5.12.1 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.

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

5.12 Credit Distribution

The credit distribution is detailed in the Table.

	Credits
Semester I to VI	
Language-I (Tamil or any other Language)	12
Language-II (English)	12
Core Courses	60-65
Allied-I	10
Allied-II	10
Electives	15
Soft skills	12
Environmental studies (UGC mandated)	2
Value Education	2
Experiential learning	4
Extension activities	1
Total Credits (Semester I to VI)	**140-145**
Semester VII to X	
Core Courses	65-75
Electives	15
Project	6-8
Total Credits (Semester VII to X)	**90-95**
Total Credits Semester I to X (Minimum requirement for the award of Degree)	***230-240**

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 230-240 credits.*

5.13 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 per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) 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 students 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 organisation of lesson plan of the Course Instructor.

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

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor 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 should earn a minimum of 75% attendance in 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.

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 a 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, seminars, and viva-voce that would be suitable for the course. 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 pattern of question paper will be decided by the respective faculty.

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 to three 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.

8.5 End Semester Examinations (ESEs)

8.5.1 The ESEs for the odd semester will be conducted in November and for the even semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) will be permitted to reappear in such course(s) in the subsequent semester/year.

8.5.3 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. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

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

9.1.3 For the Practical courses, the CIA Tests will constitute 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 Instructor

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

	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:

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

9.3 Assessment of End-Semester Examinations

9.3.1 Double Evaluation for the ESE is done by the University Teachers.

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

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

9.4.3 CIA for Project will consist of Review of literature, 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 of the Head of the Department, Project Supervisor, and a senior faculty.

9.4.7 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 VACs shall be evaluated completely by Internal Examiners.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A candidate is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 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 of 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 from the first semester to the current semester.

11.3 The GPA is calculated by the formula

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n 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.

$$CGPA = \frac{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{m} \sum_{i=1}^{n} C_i}$$

where, C_i is the Credit earned for the Course i in any semester;

G_i is the Grade Point obtained by the student for the Course i and

n is the number of Courses passed in that semester.

m is the number of semesters.

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

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

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

11.6.1 For **First Class with Distinction:** Candidates who have passed all the courses prescribed in the Programme *in the first attempt* with a CGPA of 8.25 or 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 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

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

11.6.4 Candidates who obtain highest marks in all examinations at the first appearance alone will be considered 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 candidate 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 completed successfully, 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 card 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 student has re-appeared.

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 or more 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.

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

12.4 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.

12.5 Withdrawal is **not** granted for arrear examinations of courses in previous semesters (for which the student has secured RA Grade) and for the final semester examinations.

12.6 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) in the subsequent semester.

12.7 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the student 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 department library or computer resources, stealing other students' notes/assignments, 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 sensitised 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 Five Year Integrated 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.*

Programme Structure
(For students admitted from the academic year 2019-2020)
Total Credits: up to Six semesters 144; for all the Ten semesters 239

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19ITAC11	**Language-I: Course 1**	3		3	25	75	100
19IENC12	**Language-II: Course 1**	3		3	25	75	100
19ICEC13	Civics, Environmental Awareness and Health Sciences	3		3	25	75	100
19IPHY14	Ancillary– Physics -I	4		4	25	75	100
19IMAT15	Core 1: Classical Algebra	5		5	25	75	100
	Elective: Matrices	3		3			
				21			
Semester-II							
19ITAC21	**Language-I: Course 2**	3		3	25	75	100
19IENC22	**Language-II: Course 2**	3		3	25	75	100
19ICAC23	Computer Applications – I	3		3	25	75	100
19IPHY24	Ancillary-Physics –II	4		4	25	75	100
	Ancillary –Physics Practical		6	3	40	60	100
19IMAT25	Core 2: Trigonometry	5		5	25	75	100
19IMAT26	Core 3: Differential Calculus	5		5	25	75	100
				26			
Semester-III							
19ITAC31	**Language-I: Course 3**	3		3	25	75	100
19IENC32	**Language-II: Course 3**	3		3	25	75	100
19ISAT33	Ancillary– Mathematical Statistics -I	4		4	25	75	100
19IMAT34	Core 4: Analytical Geometry 2D	5		5	25	75	100
19IMAT35	Core 5: Vector Analysis	5		5	25	75	100
	Elective: Integral Calculus	3		3			
				23			
Semester-IV							
19ITAC41	**Language-I: Course 4**	3		3	25	75	100
19IENC42	**Language-II: Course 4**	3		3	25	75	100
19ISAT43	Ancillary– Mathematical Statistics –II	4		4	25	75	100
19IMAT44	Core 6: Statics	5		5	25	75	100
19IMAT45	Core 7: Fourier Series and Fourier Transforms	5		5	25	75	100
				20			
Semester-V							
19IMAT51	Core 8: Real Analysis – I	5		5	25	75	100
19IMAT52	Core 9: Differential Equations and Applications	5		5	25	75	100
19IMAT53	Core 10: Dynamics	5		5	25	75	100
19IMAT54	Core 11: Astronomy	5		5	25	75	100

19IMAT55	Core 12: Numerical Methods	5		5	25	75	100
	Elective: Analytical Geometry 3D	3		3			
				28			
Semester-VI							
19IMAT61	Core 13: Real Analysis – II	5		5	25	75	100
19IMAT62	Core 14: Complex Analysis	5		5	25	75	100
19IMAT63	Core 15: Algebra	5		5	25	75	100
19IMAT64	Core 16: Discrete Mathematics	5		5	25	75	100
19IMAT65	Core 17: Optimization Techniques	6		6	25	75	100
				26			
Semester-VII							
19IMAT71	Core 18: Advanced Abstract Algebra I	5		5	25	75	100
19IMAT72	Core 19: Advanced Real Analysis	5		5	25	75	100
19IMAT73	Core 20: Advanced Differential Equations	5		5	25	75	100
19IMAT74	Core 21: Differential Geometry	5		5	25	75	100
	Elective 1: Interdepartmental Elective	3		3	25	75	100
				23			
Semester-VIII							
19IMAT81	Core 22: Advanced Abstract Algebra II	5		5	25	75	100
19IMAT82	Core 23: Measure Theory and Integration	5		5	25	75	100
19IMAT83	Core 24: Advanced Complex Analysis	5		5	25	75	100
19IMAP84	Core 25: C++ Computer Practical		4	2	40	60	100
	Elective 2: Interdepartmental Elective	3		3	25	75	100
	Elective 3: Department Elective	3		3	25	75	100
				23			
Semester-IX							
19IMAT91	Core 26: Topology	3		5	25	75	100
19IMAT92	Core 27: Linear Algebra	4		5	25	75	100
19IMAT93	Core 28: Probability Theory	4		5	25	75	100
19IMAT94	Core 29: Numerical Methods Practical		4	2	40	60	100
	Elective 4: Interdepartmental Elective	3		3	25	75	100
	Elective 5: Department Elective	3		3	25	75	100
				23			
Semester-X							
19IMAT101	Core 30: Functional Analysis	4		4	25	75	100
19IMAT102	Core 31: Stochastic Processes	4		4	25	75	100
19IMAT103	Core 32: Fluid Dynamics	4		4	25	75	100
19IMAT104	Core 33: Graph Theory	4		4	25	75	100
19IMAT105	Core 34: Calculus of Variations & Integral Equations	4		4	25	75	100
19IMAPJ106	Project	6		6	25	75	100
				26			
	Total Credits			**239**			
	Value Added Courses						

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

1. **Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.**
2. **Students may opt for any Value-added Courses listed in the University website.**

Elective Courses

Department Elective (DE)

S. No.	Course Code	Course Title	hours/ week		C	Marks		
			L	P		CIA	ESE	Total
1.	19IMAT86-1	Programming Language C++	3	0	3	25	75	100
2.	19IMAT96-1	Number Theory	3	0	3	25	75	100
3.	19IMAT96-2	Fuzzy Sets and their Applications	3	0	3	25	75	100

Interdepartmental Electives (IDE)

S. No.	Course Code	Course Title	Department	Hours/ week		C	Marks		
				L	P		CIA	ESE	Total
1.	19 SOSE 115.1	Soft Skills	English	3	0	3	25	75	100
2.	19 MATE 215.1	Discrete Mathematics	Mathematics	3	0	3	25	75	100
3.	19 MATE 215.2	Numerical Methods		3	0	3	25	75	100
4.	19 MATE 215.3	Statistical Computing		3	0	3	25	75	100
5.	19 MATE 315.1	Differential Equations		3	0	3	25	75	100
6.	19 STSE 215.1	Statistical Methods	Statistics	3	0	3	25	75	100
7.	19 STSE 215.2	Mathematical Statistics		3	0	3	25	75	100
8.	19 STSE 315.1	Bio-Statistics		3	0	3	25	75	100
9.	19 PHYE 215.1	Classical Mechanics and Special Theory of Relativity	Physics	3	0	3	25	75	100
10.	19 PHYE 215.2	Physics of the Earth		3	0	3	25	75	100
11.	19 PHYE 315.1	Bio-Medical Instrumentation		3	0	3	25	75	100
12.	19 PHYE 315.2	Energy Physics		3	0	3	25	75	100
13.	19 BOTE 215.1	Plant Tissue Culture	Botany	3	0	3	25	75	100
14.	19 BOTE 215.2	Plant Science – I		3	0	3	25	75	100
15.	19 BOTE 315.1	Gardening and Horticulture		3	0	3	25	75	100
16.	19 BOTE 315.2	Plant Science – II		3	0	3	25	75	100
17.	19 ZOOE 215.1	Animal Culture Techniques	Zoology	3	0	3	25	75	100

18.	19 ZOOE 315.1	Environmental Science		3	0	3	25	75	100
19.	19 GEOE 215.1	Environmental Geosciences	Earth Sciences	3	0	3	25	75	100
20.	19 GEOE 315.1	Applied Geophysics		3	0	3	25	75	100
21.	19 BIOE 215.1	Basic Biochemistry	Biochemistry & Biotechnology	3	0	3	25	75	100
22.	19 BIOE 215.2	Basic Biotechnology		3	0	3	25	75	100
23.	19 BIOE 315.1	Biochemical Techniques		3	0	3	25	75	100
24.	19 BIOE 315.2	Immunology		3	0	3	25	75	100
25.	19 MIBE 315.1	Microbiology	Microbiology	3	0	3	25	75	100
26.	19 CSCE 215.1	R Programming	Computer & Information Science	3	0	3	25	75	100

Electives Offered to Other Departments

S. No.	Course Code	Course Title	Hours/ week		C	Marks		
			L	P		CIA	ESE	Total
1.	19 MATE 815.1	Discrete Mathematics	3	0	3	25	75	100
2.	19 MATE 815.2	Numerical Methods	3	0	3	25	75	100
3.	19 MATE 915.1	Differential Equations	3	0	3	25	75	100

Value Added Course

Course Code	Course Title	Hours/ week		C	Marks		
		L	P		CIA	ESE	Total
VAC	Mathematics for Competitive Examinations	3	0	3	25	75	100

19IMAT - Core Course;
Elective Course (IDE) - Inter Department Elective Course;
Elective Course (DE) - Department Elective Course;
19IMAP - Practical;
19IMAD - Project (Dissertation & Viva-voce);
IA – Internal Assessment Evaluation Marks;
E - End Semester examination marks.
* - 75 Marks = 50 [Valuation of Dissertation] + 25 [Viva]

Students can take courses available in MOOC / SWAYAM portal and the marks obtained in the courses are added in the mark statement under the head “Extra Credit Courses”.

Programme Outcomes

PO1: Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2: Resource Utilisation. Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3: Analytical and Technical Skills: Ability to handle/use appropriate tools/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 in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5: Project Management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.

PO6: Individual and team work: Exhibit the potential to effectively accomplish tasks independently 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 and documentation.

PO8: Environment and Society: Analyse the impact of scientific and technological advances on the 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

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 real life situations.

Syllabus

Language-I – தமிழ்

Course 1 - 19ITAC11: நவீன இலக்கியமும் நாடகமும்

மதிப்பெண் : 75

கிரடிட் : 3

நோக்கம்: தமிழில் தோன்றிய நவீன இலக்கியங்கள் குறித்து அறிமுகம் செய்தல். நவீன இலக்கியங்கள் குறித்த வரையறை - தோற்ற பின்னணி - நவீன இலக்கிய வகைகள் - உரைநடை - புதுக்கவிதை - செய்தித்தாள் - நாடகம் போன்றவற்றின் வரலாற்றை விளக்குதல். இலக்கியங்களையும் அவை தொடர்பான இலக்கிய வரலாற்றையும் இணைத்;துப் படித்தல்.

அலகு – 1: சிறுகதை

1. புதுமைப்பித்தன் - பால்வண்ணம் பிள்ளை
2. கி.ராஜநாராயணன் - கதவு
3. கு.அழகிரிசாமி - ராஜா வந்திருக்கிறார்
4. கண்மணி குணசேகரன் - உயிர்த் தண்ணீர்
5. மேலாண்மை பொன்னுச்சாமி - தேசிய மயில்

அலகு – 2: புதுக்கவிதை

1. பாரதியார் - புதுமைப்பெண்
2. பாரதிதாசன் - தமிழ் உணவு
3. உவமைக் கவிஞர் சுரதா - தமிழில் பெயரிடுங்கள்
4. தேவதேவன் - புகட்டல்
5. அறிவுமதி - நட்புக்காலம் (முதல் 20 மட்டும்)
6. மித்ரா - ஹைகூ என் தோழி (முதல் 20 மட்டும்)

அலகு – 3: புதினம்

1. டி.செல்வராசு - பொய்க்கால் குதிரை

அலகு – 4: நாடகம்

1. இன்குலாப் - ஔவை

அலகு - 5: இக்கால இலக்கிய வரலாறு

ஐரோப்பியர் வருகை - நவீன இலக்கியங்கள் அறிமுகம் - புதுக்கவிதை - சிறுகதை - புதினம் ஆகியவற்றின் தோற்றமும் வளர்ச்சியும் - இலக்கிய முன்னோடிகள் - செய்தித்தாள் வருகை - நாடகம் - தோற்றமும் வளர்ச்சியும்.

பாட நூல் :

1. பாரதியார் - பாரதியார் கவிதைகள், நியூ செஞ்சரி புக் ஹவுஸ், சென்னை
2. பாரதிதாசன் - பாரதிதாசன் கவிதைகள், மணிவாசகர் பதிப்பகம், சென்னை.
3. ச.வே.சுப்பிரமணியன் - தமிழ் இலக்கிய வரலாறு, மணிவாசகர் பதிப்பகம், சென்னை.
4. சோ.நா.கந்தசாமி - தமிழ் இலக்கிய வரலாறு, மணிவாசகர் பதிப்பகம், சென்னை.
5. சுரதா - துறைமுகம், சுவாதி பதிப்பகம், அம்பத்தூர், சென்னை
6. டி. செல்வராசு - பொய்க்கால் குதிரை, நியூ செஞ்சரி புக் ஹவுஸ், சென்னை.

7. அறிவுமதி - நட்புக்காலம், கவிதா பதிப்பகம், சென்னை.
8. இன்குலாப் - ஔவை, அகரம் பதிப்பகம், தஞ்சாவூர்.
9. உ.கருப்பத்தேவன் - புதுமைப்பித்தன் புதுமைக்கதைகள், நிய செஞ்சரி புக் ஹவுஸ், சென்னை.
10. மித்ரா - ஹைகூ
11. தேவதேவன் - அமுதம் மாத்திரமே வெளிப்பட்டது

Language - II – English

Semester-I Course 1- 19IENC12: English Through Literature I: Prose Credits: 3
Hours: 3

Learning Objective (LO):

By introducing the course, it is intended to:

LO1: Develop the Language ability of the students
LO2: Enable students to understand the passage, to read fluently, to enrich their vocabulary, and to enjoy reading and writing
LO3: Make the students proficient in the four language skills
LO4: Make the students read with correct pronunciation, stress, intonation, pause, and articulation of voice
LO5: Develop their inquiry skill

Unit-1:

Stephen Leacock "With the Photographer"
Winston S. Churchill "Examinations"
Grammar: Introduce the Parts of speech Nouns, Verbs, Adjectives, and Adverbs

Unit-2:

G.B. Shaw "Spoken English and Broken English"
M.K. Gandhi "Voluntary Poverty"
Grammar: Articles

Unit-3:

Robert Lynd "On Forgetting"
Virginia Woolf "Professions for Woman"
Grammar: Pronouns

Unit-4:

A. G. Gardiner "On Umbrella Morals"
R.K. Narayan "A Snake in the Grass"
Grammar: Prepositions

Unit-5:

Martin Luther King (Jr.) "I Have a Dream"
George Orwell "The Sporting Spirit"
Grammar: Conjunctions & Interjections

Text Book:

1. Ayyappa Raja. S., Deivasigamani. T., Saravana Prabhakar. N., Karthikeyan. B., English through Literature: Prose.
2. David Green, Contemporary English Grammar: Structures and Composition, Macmillan.

Course Outcomes:

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

CO1: Competency in communication both in written and oral skills
CO2: Fluency in the English language
CO3: Knowledge about construction of sentence structures
CO4: English Vocabulary to use the English language effectively
CO5: Proficiency in the four communication skills

Semester-I **19IMAT15: Classical Algebra** **Credits: 5**
Hours: 5

Learning Objective (LO): In this course students are exposed to topics like Theory of Equations, Summation of Series, Matrices and Elementary Number Theory. The stress is on the development of problem solving skills.

Unit-1: Theory of Equations

Polynomial Equations - Symmetric Functions of roots in terms of Coefficients - Sum of r-th powers of roots - Reciprocal Equations - Transformation of Equations.

Unit-2: Theory of Equations (Contd...)

Descartes Rule of Signs - Approximate Solutions of Polynomials by Horner's method - Newton - Raphson method of Solution of a Cubic Polynomial.

Unit-3: Summation of Series

Summation of series using Binomial - Exponential and Logarithmic series (Theorems without proofs) - Approximation using Binomial & Exponential series.

Unit-4: Elementary Number Theory

Prime Number - Composite Number - Decomposition of a Composite Number as a Product of Primes uniquely (without proof) - Divisors of a Positive Integer - simple problems.

Unit-5: Elementary Number Theory (Contd.)

Congruence Modulo n - Euler Function (without Proof) - Highest Power of a Prime Number p contained in n! - Fermat's and Wilson's Theorems (statements only).

Text Books:

1. P. Kandasamy, K. Thilagavathy, Content and treatment as in the book Mathematics for B.Sc. Vol-I, II, III & IV, S.Chand & Company Ltd., New Delhi-55 (2004).
2. S. Narayanan, R. Hanumantha Rao, T.K. Manicavachagom Pillay and Dr. P. Kandaswamy, Ancillary Mathematics, Volume-I, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 2009.

Supplementary Reading:

1. T.K. Manicavachagom Pillay, T.Natarajan and K.S.Ganapathy, Algebra, Volume I & II, S.Viswanathan Printers & Publishers Pvt. Ltd. Chennai, 2004.
2. S. Arumugam , Algebra, New Gamma Publishing House, Palayamkottai, 2003.
3. A. Singaravelu, Algebra and Trigonometry, Vol.-I & II, Meenakshi Agency, Chennai, 2003.
4. S. Sudha, Algebra and Trigonometry, Emerald Publishes, Chennai.

B.Sc. Mathematics: Syllabus (CBCS), 1998.

Course Outcomes:

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

CO1: Apply the fundamental concept of theory of equations and to find solutions.

CO2: Apply Descarte's rule, Horner's method, Newton Raphson methods for finding approximate solutions.

CO3: Apply summation of series using Binomial, Exponential and Logarithmic series for finding approximations.

CO4: Apply the elementary number theory for highest power of prime number.

CO5: Apply the elementary number theory for Fermat's and Wilson's theorem.

Outcome Mapping:

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

Semester-I **Elective: Matrices** **Credits: 3**

Hours: 3

Learning Objective (LO): In this course students are trained to develop skills in finding rank, inverse, Eigen values, Eigen vectors and quadratic forms.

Unit-1:

Rank of the Matrix – Inverse of the Matrix.

Unit-2:

Symmetric – Skew Symmetric – Hermitian – Skew Hermitian – Orthogonal and Unitary matrices.

Unit-3:

Eigen values – Eigen vectors – Cayley Hamilton theorem.

Unit-4:

Diagonalisation by similarity transformation.

Unit-5:

Quadratic Forms – Nature of Quadratic Forms.

Text Book:

1. S. Narayanan, R. Hanumantha Rao, T.K. Manicavachagom Pillay and Dr. P. Kandaswamy, Ancillary Mathematics, Volume-I, S. Viswanathan (Printers & Publishers) Pvt. Ltd., 2009.

Supplementary Reading:

1. K. Vairamanickam, Nirmala P. Ratchagar and S. Tamilselvan, Engineering Mathematics, Scitech Publications (India) Pvt. Ltd., Chennai, 2009.
2. Richard Bellman, Introduction to Matrix Analysis, Second Edition, T.M.G. Publishing Company Ltd., New Delhi, 1974.

Course Outcomes:

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

CO1: Find the rank and inverse of a matrix.

CO2: Find Eigen Values and Eigen Vectors.

CO3: Diagonalize the matrix using similarity transformation.

CO4: Find the nature of Quadratic forms.

Outcome Mapping:

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

Language-I – தமிழ்

Course 2 - 19ITAC21: பக்தி இலக்கியமும் சிற்றிலக்கியமும்

மதிப்பெண்: 75

கிரடிட்: 3

நோக்கம் : தமிழ்ப் பக்தி இலக்கியங்களையும் சிற்றிலக்கியங்களை அறிமுகம் செய்தல். பக்தி இலக்கியத்தின் செல்வாக்கு - தோற்றம் வளர்ச்சி - பாகுபாடு - தமிழின் தனித்தன்மையை உணர்த்திய பாங்கு போன்றவற்றை வரலாற்றுடன் விளக்குதல். இலக்கியங்களையும் அவை தொடர்பான இலக்கிய வரலாற்றையும் இணைத்;துப் படித்தல்.

அலகு – 1: பக்தி இலக்கியம்

1. திருஞான சம்பந்தர் - திருநள்ளாறு – பச்சை பதிகம் (முதல் 5 பாடல்கள்)
2. திருமூலர் - திருமந்திரம் (உடம்பினை முன்னை, யாவர்க்குமாம், ஒன்றே குலமும், உள்ளம்பெருங்கோயில், ஆர்க்கும் எனத் தொடங்கும் பாடல்கள்)
3. சிவவாக்கியர் - அறிவுநிலை (5 பாடல்கள்)

அலகு – 2: பக்தி இலக்கியம்

1. ஆண்டாள் - திருப்பாவை (முதல் 5 பாடல்கள்)
2. வள்ளலார் - திருவருட்பா – பிள்ளைச் சிறு விண்ணப்பம்

அலகு – 3: பக்தி இலக்கியம்

1. தேம்பாவணி - குழவிகள் வதைப்படலம்
2. சீறாப்புராணம் - மானுக்குப் பிணை நின்ற படலம்

அலகு – 4: சிற்றிலக்கியம்

1. குற்றாலக் குறவஞ்சி - மலை வளம் (வானரங்கள்... பாடல் முதல்)
2. முக்கூடற்பள்ளு - நாட்டு வளம்

அலகு – 5: இலக்கிய வரலாறு

பக்தி சிற்றிலக்கிய வரலாறு - இடைக்காலத் தமிழகச் சூழல் - சைவ வைண சமயங்களின் செல்வாக்கு - சமண பௌத்த சமய இலக்கியங்கள் -

கிறித்துவ இசுலாம் இலக்கியங்கள் - நாயக்கர் காலச் சிற்றிலக்கியங்கள் தோற்ற பின்னணி - சிற்றிலக்கிய வகை.

பாட நூல் :

1. ச.வே.சுப்பிரமணியன்- தமிழ் இலக்கிய வரலாறு
மணிவாசகர் பதிப்பகம், சென்னை.
2. சோ.நா.கந்தசாமி - தமிழ் இலக்கிய வரலாறு
மணிவாசகர் பதிப்பகம், சென்னை.
3. ந.வீ.செயராமன் - சிற்றிலக்கியச் செல்வம்
மணிவாசகர் பதிப்பகம், சென்னை.
4. ந.வீ. செயராமன் - பள்ளு இலக்கியம்
மணிவாசகர் பதிப்பகம், சென்னை.
5. க.ப.அறவாணன் - கலிங்கத்துப்பரணி ஒரு மதிப்பீடு
ஜைன இளைஞர் மன்றம், சென்னை.
6. கோ.கேசவன் - பள்ளு இலக்கியம்
ஒரு சமூகவியல் பார்வை
அன்னம் வெளியீடு, தஞ்சாவூர்
7. வேங்கடராமன் - பள்ளு இலக்கியங்களில் மள்ளர் மரபுகள்
தேவேந்திர மன்றம், கோயம்புத்தூர்
8. ந.சேதுரகுநாதன், ப.ஆ., - முக்கூடற்பள்ளு கழகம் வெளியீடு, சென்னை

PART- II: Language - II – English

Semester-II Paper – II – 19IENC22: English Through Literature II: Poetry **Credits: 3**
Hours: 3

Learning Objective (LO):

By introducing the course, it is intended to:

LO1: Develop the ability of the learner to comprehend and appreciate poems in English
LO2: Enhance the competence of the learner in using the English language
LO3: Improve the interest of the learner in human values and perceptions
LO4: Enable students to study and analyze the use of language in poetry
LO5: Provide learners with the theoretical and practical understanding of grammar

Unit-1:

William Shakespeare	"Sonnet 116"
William Blake	"Lamb"
Robert Burns	"A Red, Red Rose"
Grammar	Finite & Non-finite verbs

Unit-2 :

PB Shelley	"To Wordsworth"
John Keats	"Sonnet to Sleep"
Thomas Hardy	"Neutral Tones"
Grammar	Strong and Weak Verbs, Auxiliaries and Modals

Unit-3:

Robert Frost	"Stopping By Woods on a Snowy Evening"
Wilfred Owen	"Anthem for Doomed Youth"
Emily Dickinson	"A Narrow Fellow in the Grass"
Grammar	Transitive, Intransitive Verbs, Active and Passive Voice

Unit-4:

Sri Aurobindo	"The Tiger and the Deer"
AK Ramanujan	"Obituary"
Sarojini Naidu	"Queen's Rival"
Grammar	Concord

Unit-5:

Roger Mc Gough	"My Bus Conductor"
Maya Angelou	"Still I Rise"
Langston Hughes	"The Negro Speaks of Rivers"
Grammar	Tenses and their forms

Supplementary Reading:

- Hydes, Jack.*Touched With Fire.* London: Cambridge UP, 1985.
- Narasimhaiah, C. D. *An Anthology of Common Wealth Literature*. New Delhi: Macmillan, 2006.
- Thomas, C. T. *Twentieth Century Verse: An Anglo-American Anthology*. New Delhi: Macmillan, 2006.
- Gates, Henry Louis, and Nellie Y. McKay.*The Norton Anthology of African American Literature.*New York: W.W. Norton & Co, 2004.
- Ramachandran. C. N. and Radha Achar. *Five Centuries of Poetry.* New Delhi: Laxmi, 1998.

Course Outcomes:

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

CO1: Competency in communication, both in written and oral skills
CO2: Fluency in English language
CO3: Knowledge about construction of sentence structures
CO4: Vocabulary to use the English language effectively
CO5: Acquire the aesthetic sense for appreciating poetry

Semester-II **19IMAT25: Trigonometry** **Credits: 5**
Hours: 5

Learning Objective (LO): This course is a fundamental one for many courses of this Degree Programme. This covers topics on the expansions of trigonometric functions, hyperbolic functions, inverse circular, inverse hyperbolic functions and it aims to develop computational skills.

Unit-1:

Expansions of cos nθ, sin nθ – Expansion of tan nθ in terms of tan θ – Expansion of tan(A+B+C+…) – Formation of Equations.

Unit-2:

Powers of sines and cosines of θ in terms of functions of multiples of θ – expansions of sin θ and cos θ in a series of ascending powers of θ – Approximations.

Unit-3:

Definition – Relation between Hyperbolic Functions – Inverse Hyperbolic Functions.

Unit-4:

Resolution into Factors – simple problems only – DeMoivre's property on the Circle and Cote's Property on the Circle. Logarithm of complex quantities.

Unit-5:

Summation of Trigonometric Series: When the angles are in A.P, C+iS method of summation – Method of Differences – Gregory Series – Euler Series.

Text Book:

S. Narayanan and T.K. Manicavachagom Pillay, Content and treatment as in the book Trigonometry, S.Viswanathan Printers & Publishers Pvt. Ltd. Chennai 2009.

Unit– I Chapter III sections 1 to 3

Unit– II Chapter III sections 4 and 5

Unit– III Chapter IV

Unit– IV Chapter V

Unit– V Chapter VI sections 1 to 3

Supplementary Reading:

1. P.Kandasamy, K.Thilagavathy, Mathematic for B.Sc. Vol.-I, II, III & IV, S.Chand & Company Ltd., New Delhi-55, 2004.
2. S.Duraipandian and Laxmi Duraipandian, Trigonometry. Emerald Publishers, Chennai, 1984.
3. B.S.Grewal, Higher Engineering Mathematics. Khanna Publishers. New Delhi, 2002.
4. S.L.Loney, Plane Trigonometry, Part II, Cambridge University Press, London, 1982.
5. A.Singaravelu, Algebra and Trigonometry, Vol.-I Meenakshi Agency, Chennai, 2003.
6. P.R.Vittal, Trigonometry, Margham Publications, Chennai, 2004.

Course Outcomes:

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

CO1 : Apply for finding expansions of cos$n\theta$, sin$n\theta$ and tan$n\theta$ and formation of equations.

CO2: Apply for finding cosθ, sinθ in a series of ascending powers of θ and their approximation.

CO3: Apply for finding Hyperbolic and inverse Hyperbolic functions.

CO4: Apply for resolution into factors and study De-Moivre's property.

CO5: Apply to evaluate the summation of trigonometric series and their differences, Gregory series and Euler series.

Outcome Mapping:

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

Semester-II **19IMAT26: Differential Calculus** **Credits: 5**

Hours: 5

Learning Objective (LO): This course develops problem solving skills in differential calculus and applications of differential calculus.

Unit-1:

The nth derivative, Leibnitz theorem and its applications, Total differential, $\frac{d^2y}{dx^2}$ and $\frac{dy}{dx}$ in terms of partial derivatives of f when f(x,y)=0, Jacobians.

Unit-2:

Maxima and minima of functions of two independent variables, Necessary and sufficient conditions, Lagrange's method, Problems on maxima and minima (second order conditions must be verified for maxima and minima).

Unit-3:

Polar coordinates - Angle between radius vector and tangent, Angle of intersection of two curves, Slope of the tangent, Pedal equation of a curve, Simple problems.

Unit-4:

Curvature: Radius of curvature – Cartesian formula for radius of curvature – Parametric formula for radius of curvature – Radius of curvature in polar co-ordinates – Centre of curvature in Polar co-ordinates.

Unit-5:

Envelope of one parameter family of curves - Envelope of two parameter family – Asymptotes – Definition – Methods of finding Asymptotes to plane algebraic curves.

Text Book:

S.Narayanan and T.K.Manicavachagom Pillay, Content and treatment as in the book Calculus, Volume – I (Differential Calculus), S. Viswanathan Publishers, 1995.

Supplementary Reading:

1. M.K.Venkataraman, Engineering Mathematics, The National Publishing Company, Madras.
2. P. Kandasamy, K. Thilagavathy and K. Gunavathy,Engineering Mathematics, S. Chand and Company, 2006.

Course Outcomes:

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

CO1: Apply Leibnitz theorem for n^{th} derivative, total differentials in terms of partial derivatives and Jacobians.

CO2: Apply maxima and minima functions for two and three independent variables.

CO3: Apply for finding, angle between vectors, pedal equations and finding solutions.

CO4: Apply for finding radius of curvature and centre of curvature.

CO5: Apply for finding envelope and Asymptotes.

Outcome Mapping:

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

CO4	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓

Language-I – தமிழ்

Course 3 - 19ITAC31: அற இலக்கியமும் காப்பியமும்

மதிப்பெண்கள் : 75

கிரடிட் : 3

நோக்கம்: தமிழில் தோன்றி அற இலக்கியங்களையும் காப்பிய இலக்கியங்களையும் அறிமுகம் செய்தல். அவற்றின் வகைகளை வரலாற்றுடன் விளக்குதல். இலக்கியங்களையும் அவை தொடர்பான இலக்கிய வரலாற்றையும் இணைத்;துப் படித்தல்.

அலகு – 1: அற இலக்கியம்

1. திருக்குறள் - உழவு, ஒழுக்கமுடைமை, காலமறிதல், நட்பு, பிரிவாற்றாமை

அலகு – 2: அற இலக்கியம்

1. நாலடியார் - பெரியாரைப் பிழையாமை
2. பழமொழி நானூறு - கல்வி

அலகு – 3: காப்பியம்

1. சிலப்பதிகாரம் - இந்திர விழவு ஊரெடுத்த காதை
2. மணிமேகலை - ஆபுத்திரன் திறன் அறிவித்த காதை

அலகு – 4: காப்பியம்

1. பெரிய புராணம் - அப்பு+தி அடிகள் புராணம்
2. கம்பராமாயணம் - வாலி வதைப்படலம்

அலகு – 5: இலக்கிய வரலாறு

சங்க மருவிய கால அற இலக்கியங்கள் – திருக்குறளின் பெருமை – அற இலக்கியங்களின் வளர்ச்சி – காப்பிய இலக்கணம் – பகுப்புகள் – காலந்தோறம் தோன்றிய காப்பியங்கள் – வரலாறு.

பாட நூல்கள்:

1. ச.வே.சுப்பிரமணியன் - தமிழ் இலக்கிய வரலாறு மணிவாசகர் பதிப்பகம், சென்னை.
2. சோ.ந.கந்தசாமி - தமிழ் இலக்கிய வரலாறு மணிவாசகர் பதிப்பகம், சென்னை.
3. -------- - பதினெண்கீழ்க்கணக்கு நூல்கள் மணிவாசகர் பதிப்பகம், சென்னை
4. இளங்கோவடிகள் - சிலப்பதிகாரம்
5. சீத்தலைச்சாத்தனார் - மணிமேகலை
6. சேக்கிழார் - பெரியபுராணம்
7. கம்பர் - கம்பராமாயணம்

PART- II: Language - II – English

Semester-III **Paper – III – 19IENC32: English Through Literature III: Drama** **Credits: 3**
Hours: 3

Learning Objective (LO):

By introducing the course, it is intended to:

LO1: Enhance the conversational competence of the learners by introducing drama in English.
LO2: Make the students the understand characteristics of the Elizabethan Age.
LO3: Make the students appreciate Shakespearean drama.
LO4: Make the students learn the key elements of sentence structures.
LO5: Make the students master the mechanics of writing.

Unit-1:

William Shakespeare	*The Tempest* (Act I)
Grammar	"Phrases and Clauses"

Unit-2:

William Shakespeare	*The Tempest* (Act II)
Grammar	"Simple, Compound, and Complex Sentences"

Unit-3:

William Shakespeare	*The Tempest* (Act III)
Grammar	"Transformation of Sentences"

Unit-4:

William Shakespeare	*The Tempest* (Act IV)
Grammar	"Sequence of Tenses and Reported Speech"

Unit-5:

William Shakespeare	*The Tempest* (Act V)
Grammar	"Punctuation and Capitals"

Text Books:

1. Shakespeare, William. The Tempest. Ed. W. Turner. New Delhi: S. Chand & Co., 2008.
2. Green, David. Contemporary English Grammar, Structures, and Composition. Chennai: MacMillan, 2010.

Supplementary Reading:

1. Cahn, L Victor. Shakespeare the Playwright: A Companion to the Complete Tragedies Histories, Comedies, and Romances. London: Praeger, 1996.
2. Crystal, David. Shakespeare's Words: A Glossary and Language Companion. London: Penguin, 2009.
3. Greenbaum , Sidney. Oxford English Grammar. London: Oxford UP, 2005.
4. McCarthy. Cambridge Grammar of English. London: Cambridge UP, 2018.
5. Quirk, Randolph. A Comprehensive Grammar of the English Language. London: Pearson, 2010.

Course Outcomes:

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

CO1: Obtain a literary acumen to answer MCQs of NET/SET Examinations and other competitive examination.
CO2: Appreciate conversational English.
CO3: Recognize the dramatic elements of Shakespearean dramas.
CO4: Use punctuations and capitals effectively in their Composition.

CO5: Recognize the elements of the spoken discourses.

Semester-III **19ISAT33: Mathematical Statistics – I** **Credits: 4**
Hours: 4

Learning Objective (LO): The objective is to train students in some concepts in mathematical statistics. The notion of random variables, distribution function and characteristic functions are introduced. Some examples of discrete and continuous random variables are introduced and their properties are studied.

Unit-1: Random Variables

The concept of a random variable, The distribution function, Random variables of the discrete type and the continuous type, functions of random variables, Multi dimensional random variables, Marginal distributions, Conditional distributions, Independent random variables, Functions of multi dimensional random variables.

Unit-2: Parameters of the distribution of a random variable

Expected values, Moments, The Chebyshev inequality, Absolute moments, Order parameters, Moments of random vectors, Regression of first type, Regression of the second type.

Unit-3: Characteristic Functions

Properties of characteristic functions, The characteristic functions and moments, Emi invariants, The characteristic function of the sum of independent random variables, Determination of the distribution function by the characteristic function, The characteristic function of multidimensional random vectors, Probability generating functions.

Unit-4: Some Probability Distributions

One point and two point distributions, The Bernoulli scheme, The binomial distribution, The Poisson scheme, The generalized binomial distribution, The Polya and hypergeometric distributions, The Poisson distribution.

Unit-5: Some Probability Distributions (Continued)

The uniform distribution, The normal distribution, The gamma distribution, The beta distribution, The Cauchy and Laplace distributions, The multidimensional normal distribution, The multinomial distribution.

Text Book:

Marek Fiszs, John Wiley, Content and treatment as in the book Probability Theory and Mathematical Statistics, New York, (Third edition), 1963.

Unit – I Chapter 2: Sections 2.1 to 2.9.
Unit – II Chapter 3: Sections 3.1 to 3.8.
Unit – III Chapter 4: Sections 4.1 to 4.7.
Unit – IV Chapter 5: Sections 5.1 to 5.5.
Unit – V Chapter 5: Sections 5.6 to 5.12.

Supplementary Reading:

1. H. Cramer, Random variables and probability distributions, University Press, Cambridge, 1970.
2. H. Cramer, Mathematical methods in Statistics, Princeton University Press, Princeton, 1999.
3. Samuel S. Wilks, Mathematical Statistics, John Wiley & sons, Read Books Ltd, 2018.

Course Outcomes:

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

CO1: Gains working knowledge related to the problems of theoretical statistics
CO2: Apply the fundamental concept of statistical methods to solve some real life problems

CO3: Gains a basic knowledge for study advanced courses in this area.

Outcome Mapping:

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

Semester-III **19IMAT34: Analytical Geometry 2D** **Credits: 5**
Hours: 5

Learning Objective (LO): Students are exposed to fundamental aspects of Two Dimensional Analytical Geometry and it develops logical and systematic computational skills.

Unit-1: Parabola

Equation of a Parabola, Different forms, The Pole of line with Parabola.

Unit-2: Ellipse

Equation of an Ellipse, Tangents and Normals drawn from ellipse.

Unit-3: Hyperbola

Equation of Hyperbola, with other properties of hyperbola.

Unit-4: Polar Equations

Transformation of polar co-ordinates into Cartesian co-ordinates and vice versa with other properties.

Unit-5: General Equation of the Second degree tracing of conics.

Text Book:

T.K. Manickavachagom Pillay and T. Natarajan, Content and treatment as in the book Analytical Geometry, (Part-I – Two Dimensions), S.Viswanathan Printers & Publishers Pvt. Ltd., Chennai 2009.

Unit – I: Chapter VI (Fully)
Unit-II: Chapter VII (Fully)
Unit- III: Chapter VII (Fully)
Unit- IV: Chapter IX (Fully)
Unit- V: Chapter X (Fully)

Supplementary Reading:

1. P.Duraipandian and Laxmi Duraipandian, Analytical Geometry-2D, Asia Publishing Company, Bombay, 1965.
2. G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, Addison Wesley (9th Edn.), Mass. (Indian Print), 1998.
3. P.R.Vittal, Coordinate Geometry, Margham Publishers, Chennai, 2003.

Course Outcomes:

On a successful completion of the course, the students will able to

CO1: Explain the fundamental concepts of analytical geometry in 2D about parabola, Equation of a Parabola, the pole of line with Parabola, Ellipse, equation of an Ellipse, tangent and normal drawn from Ellipse.

CO2: Hyperbola, Equation of Hyperbola, Co-ordinates of a point on the Hyperbola in terms of a single parameter tangent and normal drawn from Hyperbola, Rectangular Hyperbola.

CO3:Transformation of polar co-ordinates into Cartesian co-ordinates and vice versa, parallel straight lines, the polar equation of a conic, general equation of the second degree tracing of conics.

Outcome Mapping:

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

Semester-III **19IMAT35: Vector Analysis** **Credits: 5**
Hours: 5

Learning Objective (LO): The objective of the module is to introduce and develop the methods of vector analysis. These methods provide a natural aid to the understanding of geometry and some physical concepts. They are also a fundamental tool in many theories of Applied Mathematics.

Unit-1: Vector Algebra

Vectors, Operations with vectors, Space coordinates, Resolution of vectors, Direction cosines and Direction ratios, Section formulae, Products of two vector, Scalars or dot product,

Unit-2: Vector Algebra contd.

Vector or cross product, Physical application, Product of three or more vectors, Scalar product of three vectors, Vector product of three vectors.

Unit-3: Differential Vector Calculus

Differentiation of a Vector - Geometrical Interpretation of the Derivative - Differentiation Formulae - Differentiation of dot and Cross Products - Partial Derivatives of Vectors - Differentials of Vectors.

Unit-4: Gradient, Divergence and Curl

Vector Differential Operator Del - Gradient of a Scalar Function - Directional Derivative - Geometric Interpretation - Gradient of the sum of Functions; of the product of functions and of a function of function - Operations involving Del - Divergence of a Vector and its Physical Interpretation - Curl of a Vector and its Physical Interpretation - Expansion Formulae for Operators involving Del - Solenoidal and Irrotational.

Unit-5: Vector Integration

The Line Integral - Surface Integral and its Physical Meaning - Surface Integral and the Concept of Divergence of a Vector - Equivalence of two Definitions of Divergence - Statements of Gauss Divergence Theorem and Green's Theorem (only) and Problems - Line Integral - The Concept of the Curl of a Vector - Statement of Stoke's Theorem (only) and Problems.

Text Book:

B.S. Grewal, Content and treatment of Chapter 3 and 8 as in the book Higher Engineering Mathematics (Edition 43rd), Khanna Publishers, New Delhi, 2014.

Supplementary Reading:

1. G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, Addison Wesley (9 th Edn), Mass. (Indian Print), 1998.

2. M.K.Venkataraman, Engineering Mathematics-Part B. National Publishing Company, Chennai, 1992.
3. P.R.Vittal, Vector Calculus, Fourier series and Fourier Transform, Margham Publications, Chennai, 2004.
4. K. Vairamanickam, Nirmala P. Ratchagar and S. Tamilselvan, Engineering Mathematics – II, Scitech Publications (India) Pvt. Ltd., Chennai, 2011.
5. K. Vairamanickam, Nirmala P. Ratchagar and S. Tamilselvan, Transforms and Partial Differential Equations, Scitech Publications (India) Pvt. Ltd., Chennai, 2012.

Course Outcomes:

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

CO1: explain the fundamental concepts of vectors, direction cosines, direction ratios and workout scalar and vector products of two and three vector.

CO2: differentiate vector functions of a single variable, find the gradient, divergence and curl and prove identities involving them.

CO3: integrate vectors, compute line, surface and volume integrals in a vector field and verify Gauss, Stoke's and Green's theorem.

Outcome Mapping:

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

Semester-III **Elective: Integral Calculus** **Credits: 3**
Hours: 3

Learning Objective (LO): In this paper the student is exposed to the idea of integration and different methods of integration. The application of integration to the evaluation of areas and volumes is also introduced.

Unit-1:

Introduction, Definite integral, Methods of integration, Integrals of the form

$$\int \frac{f'(x)}{f(x)}\,dx$$

$$\int F\{f(x)\}f'(x)\,dx$$

$$\int \frac{dx}{ax^2+bx+c}\,dx$$

$$\int \frac{lx+m}{ax^2+bx+c}\,dx$$

Unit-2:

Integration by parts, Bernoulli's formula, Reduction formula for the following types

$I_n = \int x^n e^{ax}$ S n→+ve integer

$I_n = \int \cos^n x \, dx$ n, positive integer

$I_n = \int sin^n x \, dx$

$I_{m,n} = \int sin^m x cos^n x dx$

Unit-3:

Change of order of integration – Properties of definite integrals.

Unit–4:

Double integrals – Double integrals in Polar coordinates – Triple integrals.

Unit–5:

Application of double and triple integrals – area, volume.

Text Book:

S. Narayanan and T.K. Manicavachogam Pillay, Content and treatment as in the book “Calculus (Major)” Vol. II, S. Viswanathan Printers, 2003.

Supplementary Reading:

G.B.Thomas and R.L.Finney. (1998) Calculus and Analytic Geometry, Addison Wesley (9th Edn), Mass. (Indian Print).

M.K.Venkataraman. (1992) Engineering Mathematics-Part B. National Publishing Company, Chennai.

Course Outcomes:

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

CO1: Solve problems using the different methods of integration.

CO2: Solve problems in double and triple integrals.

CO3: Apply double and triple integrals in finding area and volume.

Outcome Mapping:

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

Language-I – தமிழ்

Course 3 - 19ITAC41: சங்க இலக்கியமும் செம்மொழி வரலாறும்

மதிப்பெண்கள் : 75

கிரடிட் : 3

நோக்கம்: உலகச் செம்மொழியின் வரலாற்றைக் கூறுதல். தமிழ்ச் செம்மொழியின் தனிச் சிறப்புக்களையும் செம்மொழி இலக்கியங்களையும் விவரித்தல் - சங்க இலக்கியங்களின் தனித்தன்மைகளை வரலாற்றுடன் விளக்குதல்.

அலகு – 1: அக இலக்கியங்கள்

1. குறுந்தொகை - 125, 129, 177, 302, 397 (நெய்தல்)
2. நற்றிணை (குறிஞ்சி) - 206, 217, 304, 334, 382
3. ஐங்குறுநூறு - 17, 18, 71, 75, 96 (மருதம்)
4. அகநானூறு (பாலை) - 147, 303, 370
5. கலித்தொகை - 104, 105 (முல்லை)

அலகு – 2: புற இலக்கியங்கள்

1. புறநானூறு - பெண்பாற்புலவர;கள்
   76, 83, 133, 146, 178, 188, 227,
   261, 264, 278

அலகு – 3: பத்துப்பாட்டு

1. நெடுநெல்வாடை

அலகு – 4: சங்க இலக்கிய வரலாறு

தொல்காப்பியம் - சங்க காலம் - முற்சங்கங்கள் - பாட்டும் தொகையும் - தொகுப்புமுறை - தனித்தன்மைகள்.

அலகு – 5: பயன்பாட்டுத் தமிழும் செம்மொழி வரலாறும்

மொழி விளக்கம் - மொழிக்குடும்பங்கள் - உலகச் செம்மொழிகள் - இந்தியச் செம்மொழிகள் - செம்மொழித் தகுதிகள் - வரையறைகள் - வாழும் செம்மொழித் தமிழ் - தமிழின் தொன்மை - தமிழின் சிறப்புக்கள் - தமிழ்ச் செம்மொழி நூல்கள் - தமிழ் செம்மொழி அறிந்தேற்பு - பரிதிமாற்கலைஞர் முதல் தற்கால அறிஞர்கள் வரை (அறிஞர்கள் - அமைப்புகள் - நிறுவனங்கள் - இயக்கங்கள் தொடர்முயற்சிகள் - அறப்பேராட்டங்கள் - உலத் தமிழ்ச் செம்மொழி மாநாடு, கோவை-2010)

பாட நூல் :

1. ச.வே.சுப்பிரமணியன் - சங்க இலக்கியம், மணிவாசகர் பதிப்பகம்.

பார்வை நூல்கள் :

1. மு.வரதராசன் - தமிழ் இலக்கிய வரலாறு,
   சாகித்திய அகாதெமி வெளியீடு, 1998.
2. பூவண்ணன் - தமிழ் இலக்கிய வரலாறு,
   கழக வெளியீடு சென்னை.
3. தமிழண்ணல் - புதிய நோக்கில் தமிழ் இலக்கிய வரலாறு,
   மீனாட்சி புத்தக நிலையம், மதுரை 1998.
4. சி.பாலசுப்பிரமணியன் - தமிழ் இலக்கிய வரலாறு,
   பாரிநிலையம், சென்னை - 1987
5. எம்.ஆர்.அடைக்கலசாமி - தமிழ் இலக்கிய வரலாறு
   கழக வெளியீடு, சென்னை - 1994.
6. மது.ச.விமலானந்தம் - தமிழ் இலக்கிய வரலாற்றுக் களஞ்சியம், 1987.
7. கண்ணன் ப.ஆ. - புறப்பாடல்களில் பெண்பாற்புலவர்கள்

PART- II: Language - II – English

Semester-IV Paper – IV – 19IENC42: English Through Literature IV: Short Story

Credits: 3
Hours: 3

Learning Objective (LO):

By introducing the course, it is intended to:

LO1: Develop the communicative competence of learners in the English Language through training them in the skills of listening, speaking, reading, and writing.

LO2: Enable the students to know about the origin and development of short story.

LO3: Write objectively, avoiding vague, prejudice, and exaggeration.

LO4: The broad aim of this course is to enable the learner to function through the written mode of English language in all situations including classroom, library, laboratory etc.

LO5: It also aims at different levels of a short story, such as discovering an author's purpose, drawing conclusions about certain events, evaluating cause and effect, and understanding point of view.

Unit-1:

1. O' Henry — "The Gift of The Magi"
2. Ken Liu — "The Paper Menagerie"

Grammar — Synonyms and Antonyms

Unit-2:

1. Flora Annie Steel — "Valiant Vicky"
2. Oscar Wilde — "Happy Prince"

Grammar — Words often confused

Unit-3:

1. R. K. Narayan — "The Martyr's Corner"
2. Mahasweta Devi — "Draupati"

Grammar — Paragraph-Writing

Unit-4:

1. Leo Tolstoy — "How much Land Does a Man Need?"
2. Somerset Maugham — "The Verger"

Grammar — Letter-Writing

Unit-5:

1. Langston Hughes — "On the Road"
2. Premchand — "BakthiMarg"

Grammar — Precis-Writing

Supplementary Reading:

1. Srinivasa Iyengar, K.R. Indian Writingin English. Sterling Publ., 1996.
2. Swan, Michael. Practical English Usage: Oxford University Press, 2016.
3. Palmer, Frank Robert. Grammar: (by) Frank Palmer. Penguin Books, 1975.
4. Browns, Julie, ed., Ethnicity and the American Short Story. Garland, 1997.

5. Patea, Viorica, ed., Short Story Theories: A Twenty-First-Century Perspective. Rodopi, 2012.

Course outcomes:

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

CO1: Use more vocabularies while writing.

CO2: Learner can ensure about the history and development.

CO3: The learner has a development in flow of writing.

CO4: Students can come up with new ideas while reading stories from different perspectives.

CO5: Write in a style appropriate for communicative purposes.

Semester-IV **19ISAT43: Mathematical Statistics – II** **Credits: 4**
Hours: 4

Learning Objective (LO): The objective is to train students in some concepts in mathematical statistics. The theory of sample moments, significant test, sampling theory and analysis of variance are introduced. Practical problems are solved.

Unit-1: Sample Moments and their Functions

The notion of a sample- The notion of a statistic – the distribution of the arithmetic mean of independent normally distributed random variables – The x2 distribution – The distribution of the statistic (X, S) –Student's t-distribution

Unit-2: Sample Moments and their Function (Contd...)

Fisher's Z-Distribution – The distribution of X for some non-normal populations – The distribution of sample moments and sample correlation coefficients of a two-dimensional normal population – The distribution of regression coefficients – Limit distributions of sample moments.

Unit-3: Significance Tests

The concept of a statistical test – Parametric tests for small samples – Parametric tests for small samples – Parametric tests for large samples – The x^2 test – Independence tests by contingency tables.

Unit-4: Theory of sampling

Preliminary notions – Consistent estimates – Unbiased estimates – The sufficiency of an estimate – The efficiency of an estimate.

Unit-5: Analysis of variance

One-way classification – Multiple classification – A modified regression problem.

Text Book:

Marek Fisz, Content and treatment as in the book Probability Theory and Mathematical Statistics, Third Edition, John Wiley & Sons, Inc.1963.

Unit – I Chapter 9: Sections 9.1 to 9.6.

Unit - II Chapter 9: Sections 9.7 to 9.11.

Unit - III Chapter 12: Sections 12.1 to 12.4 & 12.7.

Unit - IV Chapter 13: Sections 13.1 to 13.5.

Unit - V Chapter 15: Sections 15.1 to 15.3.

Supplementary Reading:

1. H. Cramer, Random variables and probability distributions, University Press, Cambridge, 1970.
2. H. Cramer, Mathematical methods in Statistics, Princeton University Press, Princeton, 1999.

3. Samuel S. Wilks, Mathematical Statistics, John Wiley & sons, Read Books Ltd, 2018.

Course Outcomes:

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

CO1: Gains working knowledge related to the problems of theoretical statistics.

CO2: Apply the fundamental concept of statistical methods to solve some real life problems.

CO3: Gains a basic knowledge for study advanced courses in this area.

Outcome Mapping:

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

Semester-IV **19IMAT44: Statics** **Credits: 5**

Hours: 5

Learning Objective (LO): This course aims to provide basic skills and problem solving techniques in forces acting at a point, coplanar forces, moment of a set of concurrent forces, couples, reduction of coplanar system of forces, friction and equilibrium of strings and chains.

Unit-1:

Forces acting at a point, Resultant and components, Parallelogram of forces, Analytical expression for the resultant of two forces acting at a point, Triangle of forces, The polygon of forces, Lami's theorem, An extended form of the Parallelogram law of forces, Resolution of a force, Components of a force, Resultant of any number of forces acting at a point, Conditions of equilibrium of any number of forces acting upon a particle.

Unit-2:

Parallel forces and Moments, The resultant of two like and unlike parallel forces acting on a rigid body, Resultant of a number of parallel forces acting on a rigid body, Conditions of equilibrium of three coplanar parallel forces, Centre of two parallel forces, Moment of a force, Varignon's theorem of moments, Generalized theorem of moments.

Couples, Definition, Equilibrium of two couples, Equivalence of two couples, Couples in parallel planes, Representation of a couple by a vector, Resultant of a coplanar couples, Resultant of a couple and a force.

Unit-3:

Equilibrium of three forces acting on a rigid body, Rigid body subjected to any three forces, Three coplanar forces, Conditions of equilibrium, Procedure to be followed in solving any statical problem, Two trigonometrical theorems, Some artifices, Problems on parallel forces.

Unit-4:

Coplanar forces, Reduction of coplanar forces in general, Reduction of any number of coplanar forces, Conditions and alternative conditions for a system of forces to reduce to a single force or to a couple, Change of the base-point, Equation to the line of action of the resultant, Equation to the line of action of the resultant, General conditions of equilibrium.

Unit-5:

Friction, Statical, Dynamical and Limiting frictions, Laws of friction, Coefficient of friction, Angle of friction, Cone of friction, Numerical values, Equilibrium of a particle on a rough inclined plane, Equilibrium of a body on a rough inclined plane.

Text Book:

M.K. Venkataraman, Content and treatment as in the book A Text Book of STATICS, Agasthiar Book Depot, Trichy (1986).

Unit I	-	Chapters 2 all sections.
Unit II	-	Chapter 3 Sections 1to13 and Chapter 4 all sections.
Unit III	-	Chapter 5 Sections 1 to 7.
Unit IV	-	Chapter 6 Sections 1 to 13.
Unit V	-	Chapter 7 Sections 1 to 13.

Supplementary Reading:

1. R.S. Varma, Text book on STATICS, Pothishala Pvt. Ltd., Allahabad.
2. A.V. Dharmapadam, STATICS, S. Viswanathan (Printers and Publishers) Private Ltd., 1973.

Course Outcomes:

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

CO1: Apply the fundamental concept of statics to

a. demonstrate the application of vectors for the analysis of static equilibrium ;
b. analyze static equilibrium to particles and rigid bodies and apply the principles of equilibrium for analyzing beams.

CO2: Solve equations involving frictional, statistical, dynamical and limiting frictions.
CO3: Illustrate the mathematical aspects that provide the skills and problem solving in forces acting at a point, coplanar forces and equilibrium of strings and chains.

Outcome Mapping:

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

Semester-IV 19IMAT45: Fourier Series and Fourier Transform Credits: 5 Hours: 5

Learning Objective (LO): Introduce the Fourier series and its application and the concepts of Fourier transforms.

Fourier Series:

Unit-1:

Introduction, Dirichlet conditions, Euler's Formulae for Fourier Series, Theorem for the convergence of Fourier series, Fourier Series for functions of period 2π .Examples.

Unit-2:

Change of Interval -Fourier Series for functions of period 2l, Dirichlet's conditions, Examples. Fourier Series of a function with its periodic extension.

Unit-3:

Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Examples.

Fourier Transform:

Unit-4:

Fourier Integral Theorem, Fourier sine and cosine integrals, Complex form of Fourier Integral, Inversion formula for complex Fourier transform, Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation, Fourier Transform of Derivatives Examples.

Unit-5:

Theorem Fourier Cosine & Sine Transforms and their properties, Parseval's Identity for Fourier Transform, Convolution Theorem for Fourier Transform, Examples.

Text Books:

1. Unit- I, II, III: Dr. M. K. Venkataraman and Mrs. Manorama Sridhar, Content and treatment of Chapter 1 Fourier series as in the book Calculus and Fourier Series, The National Publishing company, Chennai 2001.
2. Dr. P. R. Vittal, Unit- IV & V: Content and treatment of Chapter 8 Fourier transform as in the book Differential equations, Fourier an Laplace transforms, Probability, Margham Publications, Chennai, 2006.

Supplementary Reading:

1. S. Narayanan and T.K. Manicavachagom Pillay, Calculus Volume-III, S. Viswanathan (Printers & Publisher) Pvt. Ltd. Chennai, 2008.
2. M.K.Venkataraman, Engineering Mathematics-Part B. National Publishing Company, Chennai, 1992.
3. Dr. B. S. Grewal, Higher Engineering Mathematics Edition 43rd, Khanna Publishers, New Delhi, 2014.
4. K. Vairamanickam, Nirmala P. Ratchagar and S. Tamilselvan, Engineering Mathematics – II, Scitech Publications (India) Pvt. Ltd., Chennai, 2011.
5. K. Vairamanickam, Nirmala P. Ratchagar and S. Tamilselvan. Transforms and Partial Differential Equations, Scitech Publications (India) Pvt. Ltd., Chennai, 2012.

Course Outcomes:

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

CO1: Find the Fourier series representation of a function of one variable.

CO2: Find the solution of the wave, diffusion and Laplace equations using the Fourier series.

CO3: Demonstrate the use of Fourier Transform to connect the time domain and frequency domain.

Outcome Mapping:

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

Semester-V **19IMAT51: Real Analysis – I** **Credits: 5**
Hours: 5

Learning Objective (LO): To understand various limiting behavior of sequences and series to explore the various limiting processes viz.continuity, uniform continuity, differentiability and integrability and to enhance the mathematical maturity and to work comfortably with concepts.

Unit-1: Functions & Sequences

Functions – real valued functions – equivalence – countability and real numbers – least upper bound – definition of sequence and subsequence – limit of a sequence – convergent sequence.

Unit-2: Sequences [Contd...]

Divergent sequences – Bounded sequences – Monotone sequence – Operations on convergent sequences – Operations on divergent sequences – Limit superior and Limit inferior – Cauchy sequences

Unit-3: Series of Real Numbers

Convergence and Divergence – Series with non negative terms – Alternating series – conditional convergence and Absolute convergence – Test for Absolute convergence.

Unit-4: Series of Real Numbers [Contd...], Limits and Metric Spaces

Series whose terms form a non increasing sequence – The class $\ell 2$ – Limit of a function on the real line – Metric spaces – Limits in Metric spaces.

Unit-5: Continuous Functions on Metric Spaces

Functions Continuous at a point on the real line – Reformulation – Functions Continuous on a Metric Spaces – Open Sets – Closed Sets.

Text Book:

R. Goldberg, Content and treatment as in the book Methods of Real Analysis, Oxford & IBH Publishing Co., New Delhi 2000.

Unit – I Chapter 1 Sections 1.4 to 1.7, 2.1 to 2.3
Unit – II Chapter 2 Sections 2.4 to 2.10
Unit – III Chapter 3 Sections 3.1 to 3.4 and 3.6
Unit – IV Chapter 3 Sections 3.7, 3.10, 4.1 to 4.3
Unit – V Chapter 5 Sections 5.1 to 5.5

Supplementary Reading:

1. Tom M.Apostol, Mathematical Analysis, 2nd Edition, Addison-Wesley New York, 1974.
2. Bartle, R.G. and Shebert, Real Analysis, John Wiley and Sons Inc., New York, 1976.
3. Malik, S.C. and Savita Arora, Mathematical Analysis, Wiley Eastern limited, New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.

Course Outcomes:

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

CO1: examples and counter examples

CO2: proof techniques

CO3: problem solving

studied in real analysis such as

- Real Valued Functions
- Convergence Sequence

- Cauchy Sequence
- Series of Real Numbers

Outcome Mapping:

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

Semester-V 19IMAT52: Differential Equations and Applications Credits: 5 Hours: 5

Learning Objective (LO): This course aims to provide logical skills in the formation of differential equations, to expose to different techniques of finding solutions to these equations and in addition stress is laid on the application of these equations in geometrical and physical problems. It also aims to provide logical skills in the formation and solutions techniques of partial differential equations.

Unit-1: Ordinary Differential Equations

Bernoulli Equation – Exact Differential Equations – Equations Reducible to Exact Equations – Equations of First order and Higher degree: Equations solvable for p, Equation solvable for x and Equations Solvable for y – Clairaut's Equation.

Unit-2: Ordinary Differential Equations [Contd...]

Method of Variation of Parameters – 2nd order Differential Equations with Constant Coefficients for finding the P.I's of the form eax V, where V is sin(mx) or cos(mx) and xn – Equations reducible to Linear equations with constant coefficients – Cauchy's homogeneous Linear Equations – Legendre's Linear Equations – Linear Dependence of Solutions – Simultaneous Equations with Constant Coefficients.

Unit-3: Laplace Transform

Laplace Transform, Inverse Laplace transform, Application to the first and second order linear differential equations and Simultaneous linear differential equations, Simple problems.

Unit-4: Partial Differential Equations

Partial differential equations: Formation of P.D.E. by eliminating arbitrary constants and arbitrary functions, Complete, Singular and General integral. Solution of equations of standard types: f(p,q)=0, f(x,p,q)=0, f(y,p,q)=0, f(z,p,q)=0, f(x,p)=f(y,q), and Clairaut's form. Lagrange's equation Pp+Qq=R, Simple problems.

Unit-5: Series Solution

Series solutions of first order equations, Second order linear equations, Ordinary points, Regular Singular Points and Legendre polynomials, Properties of Legendre polynomials and Bessel functions and their differential equations.

Text Books:

Content and treatment as in the following books:

1. P.R. Vittal, Differential Equations, Fourier and Laplace Transforms, Margham publications, Second Edition, 1999.
   Unit I - Chapter 2.
   Unit II - Chapter 3.
   Unit III - Chapter 7.

Unit IV - Chapter 5.

2. George F. Simmons, Differential equations with applications and historical notes, Tata McGraw Hill Pub. Co., New Delhi, Second Edition, 2003.
Unit V - Chapter 5 Sections 26 – 29
Chapter 8 Sections 44, 45 and 46
(except Gamma function)

Supplementary Reading:

1. M.D. Raisinghania and R.S. Aggarwal, Ordinary and partial Differential equations, Sultan Chand and Company Ltd., 1983.
2. M.D. Raisinghania, Ordinary and Partial Differntial Equations, S. Chand, 2006.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 2002.

Course Outcomes:

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

CO1: Explain the fundamental concepts of ordinary differential equations and their role in modern mathematics.

CO2: Use ordinary differential equations to model simple electric circuits, population growth and mass-spring systems, as well as other applications.

CO3: Demonstrate accurate and efficient use of the Laplace transforms and their applications in the solution of ordinary differential equations.

CO4: Apply problem-solving using concepts and techniques from ordinary differential equations and Laplace transforms relevant to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts.

Outcome Mapping:

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

Semester-V **19IMAT53: Dynamics** **Credits: 5**
Hours: 5

Learning Objective (LO): This course aims to provide basic skills and problem solving techniques in kinematics of point and Newton's laws of motion. Projectiles and simple harmonic motions are studied in detail. Problems in moment of inertia are also considered. The course enhances the problem solving skill of the student.

Unit-1:

Kinematics, Speed, Displacement, Velocity, Composition of velocities; Parallelogram law , Resolution of Velocities , Components of a velocity along two given directions , Triangle of velocities, Theorem, Polygon of velocities,Theorem , Resultant of several simultaneous coplanar velocities of a particle, Relative velocity, Angular velocity, Angular velocity of a particle, Relative angular velocity, Change of velocity, Acceleration, Variable acceleration, Parallelogram law of accelerations, Relative acceleration , Motion in a straight line under uniform acceleration, Motion in a straight line with variable acceleration, Space-times graph, Velocity-time curve, Velocity-space graph , To derive graphically the equations of motion of a particle under constant acceleration,

Acceleration of falling bodies, Vertical motion under gravity, Bodies freely falling downward, Motion of a particle down a smooth inclined plane, Theorem, Lines of quickest descent, Theorem.

Unit-2:

The laws of motion: Momentum, Newton's laws of motion, Composition of forces: Conservation of linear momentum, Force of friction, Presssure of a body resting on a moving horizontal plane, Motion of connected particles, Tension in the inextensible string, Atwood's machine, Work, Tension in an elastic string, Work done in stretching an elastic string, Power, Energy, Kinetic Energy, The Principle of work-Energy, Potential Energy, The principle of conservation of energy, Verification of the principle of energy in the case of a freely falling body, Velocity and acceleration of the centre of interia of a system of particles.

Unit-3:

Projectiles: Two fundamental principles, Path of a projectile, Characteristics of the motion of a projectile, The horizontal range, The velocity at time t, Range on an inclined plane.

Unit-4:

Simple harmonic motion: Simple harmonic motion in a straight line, General solution of the S.H.M. equation, Geometrical representation of a simple harmonic motion, Change of origin, Composition of two simple harmonic motions of the same period and in the same straight line, Composition of two simple harmonic motions of the same period in two perpendicular directions, Force necessary to produce simple harmonic motion, Motion of a particle suspended by a spiral spring, Horizontal oscillations of a particle tied to an elastic spring.

Unit-5:

Moment of Inertia: The definition of parallel axes, The theorem of perpendicular axes, Moments of inertia in some particular cases, Dr. Routh's rule, Equimomential systems.

Text Book:

M.K. Venkataraman, Content and treatment as in the book Dynamics, Agasthiar Book Depot, Trichy,1985.

Unit I	-	Chapter 3 all sections
Unit II	-	Chapter 4 all sections
Unit III	-	Chapter 6 sections 1 to 15
Unit IV	-	Chapter 10 sections 1 to 10
Unit V	-	Chapter 12 all sections

Supplementary Reading:

1. P. Duraipandian and Laxmi Duraipandian, Mechanics, S. Chand and Co., New Delhi, 1979.
2. A.V. Dharmapadam, Dynamics, S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1996.

Course Outcomes:

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

CO1: Apply the fundamental concept of dynamics to

a. demonstrate their understanding of the principles of kinematics and kinetics of particles and planar rigid bodies;

b. analyze planar rigid body kinematics and kinetics.

CO2: Solve equations of projectiles, moment of inertia and simple harmonic motions.

CO3: Illustrate the mathematical aspects that provide the skills and problem techniques in kinematics of point and Newton's laws of motion.

Outcome Mapping:

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

Semester-V **19IMAT54: Astronomy** **Credits: 5**
Hours: 5

Learning Objective (LO): The prime aim of this paper is to enrich the knowledge of movements of celestial objects using mathematical concepts.

Unit-1: Spherical Trigonometry - Spherical Triangle - The fundamental formulae of Spherical Trigonometry, the sine, cosine, four parts and Napier formulae (without proof).

The Celestial Sphere: Celestial coordinators - Diurnal motion - Rising and setting of a star - Sidereal time - Circumpolar star - Morning and Evening stars - Twilight - Earth - Length of the day.

Unit-2: Refraction - Tangent Formula – Cassini's formula - Effects of Refraction - Geocentric Parallax - Effects of Geocentric Parallax - Heliocentric Parallax - Effects of Heliocentric Parallax - Aberration - Its Effects.

Unit-3: Kepler's Laws - Verification of Kepler's Laws - True anomaly, Mean Anomaly - Eccentric Anomaly, Relation between them - Time - Equation of Time - Seasons - Converson of Time.

Unit-4: Moon - Sidereal Month, Lunation and Relation between them - Phases of the Moon - Lunar Libration - Surface of the Moon - Metonic Cycle - Tides - Eclipses - Shadow Cone - Minimum and Maximum number of Eclipses.

Unit-5: Planetary Phenomena - Bodes law - Elongation - Sidereal Period, Synodic period and the relation between them - Phase - Stationary Points - Solar System - Stellar Universe - A brief history of Astronomy - Astronomical Instruments.

Text Book:

Kumaravelu. S and Susheela Kumaravelu, Relevant Chapters in: Astronomy for degree classes, Rainbow Printers, Nagarcoil 2005.

Supplementary Reading:

1. Ramachandran. G.V., Astronomy.
2. George.O.Abell, Exploration of the Universe, Second Edition.

Course Outcomes:

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

CO1: the concepts of Celestial movements,

CO2: application of Spherical Trignomentry,

CO3: application of three dimensional geometry.

Outcome Mapping:

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

Semester-V **19IMAT55: Numerical Methods** **Credits: 5**
Hours: 5

Learning Objective (LO): The roll of numerical analysis is to develop and analyze the numerical techniques. In this paper, different methods for finding the roots of algebraic and transcendental equations, solutions of simultaneous equations, solutions of differential equations are concentrated. Numerical solutions of partial differential equations such as Elliptic, Poisson and Laplace equations are discussed. Numerical differentiation and integration are also evaluated.

Unit-1: Finite Differences and Difference Equations

Finite difference operator: E-Solution of first and second order linear difference equations with constant coefficients, Non-homogeneous linear difference equations with constant coefficients.

Unit-2: Interpolation, Numerical Differentiation and Integration

Interpolation, Gregory - Newton forward and backward interpolation formula, Newton's divided difference formula, Lagrange's interpolation formula for unequal intervals, Gauss interpolation formula, Numerical differentiation, Numerical Integration, Trapezoidal rule.

Unit-3: Numerical solution of algebraic and transcendental equations

Numerical solution of algebraic and transcendental equations, Bolzano's bisection method, Successive approximation method, Regula falsi method, Newton-Raphson method, Bairstow method. Numerical solution of simultaneous linear algebraic equations, Gauss elimination method, Gauss-Jordan elimination method, Gauss - Seidel iteration method, Crout's method.

Unit-4: Numerical solution of ordinary differential equation

Numerical solution of ordinary differential equations of first and second order simultaneous equations, Taylor series method, Euler's method, Improved Euler's method, Modified Euler's method, Runge-Kutta Method of second and fourth order, Milne's Predictor - corrector method – Picard's method.

Unit-5: Numerical solution of partial differential equation

Numerical solution of partial differential equations, Elliptic equation, Poisson's equation, Laplace equation, Lielamaman's iterative method, Relaxation Method, Hyperbolic equations.

Text Book:

M.K. Venkataraman, Content and treatment as in the book Numerical methods in Science and Engineering, National Publishing Co., Chennai, 2001.

Unit I - Chapter V and X.
Unit II - Chapters VI and IX.
Unit III - Chapters III and IV.
Unit IV - Chapter XI.
Unit V - Chapter XII.

Supplementary Reading:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 1998.
2. K.Sankara Rao, Numerical Methods for Scientists and Engineers by Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2001.

Course Outcomes:

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

CO1:explain finite difference operator, solve the first and second order linear difference equations with constant coefficients and non homogenous equations of the same kind.

CO2:interpolate using Newton's and Legrangian formulae, do numerical differentiation and integration, find solutions to algebraic and transcendental equation using bisection method ,approximation method, regula falsi method, Newton Raphson method and Bairstow method.

CO3: solve ODE and PDE using the methods mentionable in the syllabus.

Outcome Mapping:

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

Semester-V **Elective: Analytical Geometry 3D** **Credits: 3**

Hours: 3

Learning Objective (LO): This paper aims to understand the fundamental concepts of Analytical Geometry in Three Dimension.

Unit-1: Rectangular Cartesian Co-ordinates: Direction Cosines of a line.

Unit-2: The Plane.

Unit-3: The Straight Line.

Unit-4: The Sphere.

Unit-5: The Central Quadrics and Cone.

Text Book:

T.K. Manickavachagom Pillay and T. Natarajan, Content and treatment as in the book Analytical Geometry, (Part-II – Three Dimensions), S.Viswanathan Printers & Publishers Pvt. Ltd., Chennai 2009.

Unit – I: Chapter 1 (Fully)

Unit-II: Chapter 2 (Fully)

Unit- III: Chapter 3 (Fully)

Unit- IV: Chapter 4 (Fully)

Unit- V: Chapter 5 (Fully)

Supplementary Reading:

1. P.Duraipandian and Laxmi Duraipandian, Analytical Geometry-3D, Emerald Publishers, Chennai, 1975.
2. G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, Addison Wesley (9th Edn.), Mass. (Indian Print), 1998.
3. P.R.Vittal, Coordinate Geometry, Margham Publishers, Chennai, 2003.

Course Outcomes:

On successful completion of the course, the students will able to:

CO1: explain fundamental concepts of analytical geometry in 3D, about direction cosines of a line and the plane, equation and plane.

CO2: The straight line, symmetric form of equation of a line, equation of a line passing through two given points, the plane and the straight line, intersection of three planes.

CO3: Sphere, the length of the tangent form of point to sphere equation of a circle on a sphere,

intersection of two spheres, cone, cylinder and central quadrics.

Outcome Mapping:

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

Semester-VI **19IMAT61: Real Analysis – II** **Credits: 5**
Hours: 5

Learning Objective (LO): To understand Integration process of Riemann to develop the understanding of point wise and uniform convergence of sequence and series of functions. To enhance the mathematical maturity and to work comfortably with concepts.

Unit-1: Connectedness, Completeness

Open Sets – Connected Sets – Bounded Sets and Totally Bounded Sets – Complete Metric Spaces.

Unit-2: Compactness

Compact Metric Space – Continuous Functions on Compact Metric Spaces - Continuity of Inverse Functions – Uniform Continuity.

Unit-3: Riemann Integration

Sets of measure zero - Definition Riemann Integral – Properties of Riemann Integral – Derivatives.

Unit-4: Riemann Integration [Contd...]

Rolle's Theorem – The law of mean – Fundamental theorems of calculus – Taylor's theorem.

Unit-5: Sequences and Series of Functions

Pointwise convergence of sequences of functions – Uniform convergence of sequences of functions – consequences of uniform convergence – Convergence and uniform convergence of series of functions.

Text Book:

R.Goldberg, Content and treatment as in the book Methods of Real Analysis, Oxford & IBH Publishing Co., New Delhi.

Unit – I Ch. 6.1 to 6.4
Unit – II Ch. 6.5 to 6.8
Unit – III Ch. 7.1, 7.2 7.4, 7.5
Unit – IV Ch. 7.6 to 7.8 and 8.5
Unit – V Ch. 9.1 to 9.4

Supplementary Reading:

1. Tom M.Apostol, Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
2. Bartle, R.G. and Shebert, Real Analysis, John Wiley and Sons Inc., New York, 1976.
3. Malik, S.C. and Savita Arora, Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.

Course Outcomes:

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

CO1: Describe fundamental properties of matric spaces that lead to the formal development of matric spaces.

CO2: Demonstrate an understanding of a set of measure zero and how that are used in Riemann integral.

CO3: Differentiate point wise convergence and uniform convergence of a sequence of functions and series of functions.

Outcome Mapping:

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

Semester-VI **19IMAT62: Complex Analysis** **Credits: 5**

Hours: 5

Learning Objective (LO): This paper is an introduction to the theory of analytic functions of one complex variable. Properties of analytic functions, results on linear transformations, problems on complex integration are discussed. Calculus of residues are also studied.

Unit-1:

Analytic function: Introduction, Laws of algebra, Functions of a complex variable, Continuous functions, Analytic functions, Cauchy-Riemann equations.

Unit-2:

Conformal mapping, Bilinear transformation, Special bilinear transformation, Stereo graphical projection.

Unit-3:

Integration in the complex plane, Complex integration, Cauchy's integral theorem, Extension of Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions, Morera's theorem, Cauchy's inequality, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem.

Unit-4:

Expansion of functions in power series, Taylor's theorem, Laurent's theorem, Singular points; Pole, essential singularity and removable singularity, Weirstrass theorem, Meromorphic function, Argument principle, Rouche's theorem.

Unit-5:

Residues-Evaluation of definite integrals, Evaluation of residue at a pole, Residue theorem, Evaluation of definite integrals, Jordan's lemma.

Text Book:

S. Narayanan and T.K. Manicavachagom pillay, Content and treatment as in the book Complex Analysis, S. Viswanathan (Printers and Publishers) Pvt. Ltd., Chennai – 31.

Unit I - Chapter 1 and 2 all sections

Unit II - Chapter 3 all sections

Unit III - Chapter 4 all sections

Unit IV- Chapter 5 all sections

Unit V - Chapter 6 all sections

Supplementary Reading:

1. J.B. Conway, Functions of one Complex Variable, Springer-Verlag, 1973.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, 1995.
3. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1979.

Course Outcomes:

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

CO1: examples and counter examples

CO2: proof techniques

CO3: problem solving

studied in complex analysis such as

Analytic function,
Some mappings,
Complex integration,
Power series.

Outcome Mapping:

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

Semester-VI **19IMAT63: Algebra** **Credits: 5**

Hours: 5

Learning Objective (LO): Modern algebra plays a major role in other branches of Mathematics. Properties of groups, various subgroups such as normal subgroups, quotient groups are studied. Homomorphism of groups and rings, automorphisms of groups are discussed. The properties of rings, ideals, quotient rings and Euclidean rings are discussed.

Unit-1: Group Theory

Definition and examples of groups, Some preliminary Lemmas, Subgroups.

Unit-2: Group Theory (continued)

A Counting principle, Normal subgroups and Quotient groups, Homomorphisms.

Unit-3: Group Theory (continued)

Automorphisms, Cayley's theorem, Permutation groups.

Unit-4: Ring Theory

Definition and examples of rings, Some special classes of rings, Homomorphisms, Ideals and quotient rings.

Unit-5: Ring Theory (continued):

More on ideals and quotient rings, The field of quotients of an integral domain.

Text Book:

I.N. Herstein, Content and treatment as in the book Topics in Algebra, John Wiley and Sons, New York, 1999.

Unit I - Chapter 2: Sections 1 to 4.
Unit II - Chapter 2: Sections 5 to.7.
Unit III- Chapter 2: Sections 8 to10.

Unit IV- Chapter 3: Sections 1 to 4.
Unit V- Chapter 3: Sections 5 and 6.

Supplementary Reading:

1. R.Balakrishnan and N. Ramabhadharan, A textbook of Modern Algebra, Vikas Publishing House, Second Revised Ed., 1994.
2. J.B. Fraleigh, A first course in Abstract Algebra, Addison-Wesley, Fifth Edition,1999.

Course Outcomes:

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

CO1: explain the fundamental concepts of algebra such as groups, subgroups, quotient groups, homomorphism, automorphisms and using these ideals, Cayley's theorem and permutation groups.

CO2: demonstrate accurate and efficient use of a ring with examples, some classes of a ring, homomorphism of a ring, ideals, quotient rings and integral domain.

CO3: solve problems in the above related topic.

Outcome Mapping:

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

Semester-VI **19IMAT64: Discrete Mathematics** **Credits: 5**
Hours: 5

Learning Objective (LO): Students must understand mathematical reasoning in order to read, comprehend and construct mathematical arguments. Mathematical logic, which serves as foundation for subsequent discussion is discussed. Discrete structures such as sets and permutations are studied. Discrete probability, recurrence relations, conquer relations and principles of inclusion and exclusion are studied.

Unit-1: Logic and Counting

Propositions and logical operations, Conditional statements, Methods of Proof, Mathematical Induction. Permutations, Combinations, Pigeonhole Principle, Elements of Probability, Recurrence Relations.

Unit-2: Relations and Digraphs

Product sets and partitions, Relations and Digraphs, Paths in Relations and Digraphs, Properties of relations, Equivalence Relations, Computer Representation of Relations and Digraphs, Operations on Relations, Transitive Closure and Warshall's Algorithm.

Unit-3: Functions

Functions, Functions for Computer Science, Growth of Functions, Permutation Functions.

Unit-4: Order Relations and Structures

Partially Ordered Sets, Extremal Elements of Partially Ordered Sets, Lattice, Finite Boolean Algebras, Functions on Boolean Algebra, Circuit Designs.

Unit-5:

Languages and Finite State Machine.

Text Book:

Bernard Kolman, Robert C. Busby, Sharon Cutler Ross, Content and treatment as in the book Discrete Mathematical Structures by Prentice - Hall of India, Private Limited, New Delhi, 2002.

Unit I Chapter 2 Sections 1 to 4, Chapter 3 Sections 1 to 5.

Unit II Chapter 4 Sections 1 to 8.

Unit III Chapter 5 Sections 1 to 4.

Unit IV Chapter 6 Sections 1 to 6.

Unit V Chapter 10 Sections 3 to 5.

Supplementary Reading:

1. E.G. Goodaire and M.M. Paramenter, Discrete Mathematics with Graph Theory, Prentice Hall International Editions, New Jersey, 1998.
2. J. Matonsek and J. Nesetril, Invitation to Discrete Mathematics by Clarendon Press, Oxford, 1998.
3. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill Publication Company, 1997.

Course Outcomes:

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

CO1: examples and counter examples

CO2: Proof techniques

CO3: problem solving

studied in Discrete Mathematics such as

Logic

Relations

Functions

Some Algebraic structure

Outcome Mapping:

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

Semester-VI **19IMAT65: Optimization Techniques** **Credits: 5**

Hours: 5

Learning Objective (LO): Mathematical programming finds applications in diverse fields including Engineering, Management Sciences, Computer Science and Economics. In this course, the general linear programming problem, simplex computation procedure, revised simplex method, duality problems in linear programming and some nonlinear programming problems are covered.

Unit-1:

The General Linear Programming problem:, The linear programming problem, properties of solution to the linear programming problem, Generating extreme - point solutions. The Simplex Computational procedure: Development of a minimum feasible solution, computational procedure.

Unit-2:

The Artificial – Basis Technique: A first feasible solution using slack variables, Geometric Interpretation of the simplex procedure.

Degeneracy and anticycling procedure: Perturbation Techniques, The lowest – Index Anticycling Rules, Example of Cycling.

Unit-3:

The Revised Simplex method: The General form of the inverse, The Product form of the inverse, Computational considerations.

The Duality problems of linear programming: The unsymmetric Primal - Dual problems, the symmetric primal-dual problems, Economic Interpretation of the Primal, Dual problems.

Unit-4:

Additional computational Technique: Determining a first feasible solution, The dual simplex method, Integer programming.

The Transportation problem: The General Transportation problem, Computational procedure for solving the transportation problem, Variations of the transportation problem.

Unit-5:

Non-Linear Programming: The General problem of mathematical programming, Mathematical background, the convex programming problem, Quadratic programming, Separable programming.

Text Book:

Saul I. Gass, Content and treatment as in the book Linear Programming - methods and applications, Fifth Edition, McGraw Hill, 1994.

Unit I - Chapter 3 Sections 1, 2 and 3 and Chapter 4 Sections 1 and 2

Unit II - Chapter 4 Sections 3, 4 and 5 and Chapter 7 Sections 1, 2 and 3

Unit III - Chapter 5 Sections 1, 2 and 3 and Chapter 6 Sections 1,2 and 3

Unit IV - Chapter 9 Sections 1, 2 and 3 and Chapter 10 Sections 1, 2 and 3

Unit V - Chapter 12 Sections 1 to 5

Course Outcomes:

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

CO1: Apply for finding solutions of general linear programming by Simplex computational procedure

CO2: Apply for finding feasible solutions by Artificial technique and by Perturbation technique.

CO3: Apply for finding solutions using revised simplex method and duality problems.

CO4: Apply for finding solutions by additional computational technique and transportation problems.

CO5: Apply for finding solutions of Non-linear programming.

Supplementary Reading:

1. H.A. Taha, Operations Research - An Introduction, Sixth Edition, Macmillan publishing Co., New York, 1998.
2. G. Hadley, Linear Programming, Oxford and IBH Pub. Co., New Delhi, 1962.
3. N.S. Kambo, Mathematical Programming, Affliated East-West Press, New Delhi, 1991.
4. J.K. Sharma, Operations Research, Trinity (Laxmi Publications), New Delhi.

Outcome Mapping:

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

CO2	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓

Semester- VII **19IMAT71: Advanced Abstract Algebra – I** **Credits: 5**
Hours: 5

Learning Objective (LO): This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups and some related structures. 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.

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:
David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), Wiley Student Edition, 2004.
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. I.N. Herstein, John Wiley & Sons,Topics in Algebra (Second Edition), New Delhi, Third Reprint 2007.
2. N. Jacobson, D. Van Nostrand Co., Lectures in Abstract Algebra Vol. I, New York, 1951.
3. M. Anderson and T. Feil, A First Course in Abstract Algebra – Rings, Groups, and Fields, Chapman & Hall/CRC, 2005.
4. M. Artin, Algebra, Pearson, 2015.

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

CO1: examples and counter examples
CO2: proof techniques

CO3: problem solving

of various concepts in:

- Groups,
- Quotient Groups,
- Homomorphism of Groups,
- Group Actions,
- Direct products of Groups.

Outcome Mapping:

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

Semester-VII **19IMAT72: Advanced Real Analysis** **Credits: 5**
Hours: 5

Learning Objective (LO): The concept of derivatives of real valued functions and their properties are studied. Properties of monotonic functions, functions of bounded variations are also introduced. The concept of Riemann-Stieltjes integral and its properties are studied. The notion of convergence and uniform convergence of real valued functions and infinite series of functions are also studied.

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, Contents and treatment as in the book Mathematical Analysis, Narosa Publishing House, (Second Edition), New Delhi, 1974.

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.

Supplementary Reading:

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

Course Outcomes:

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

CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving

studied in real analysis such as

- Functions of bounded variations,
- Riemann –Stieltjes Integral,
- Sequence of functions,
- Multivariate Differential Calculus.

Outcome Mapping:

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

Semester-VII 19IMAT73: Advanced Differential Equations Credits: 5 Hours: 5

Learning Objective (LO): 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.

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. E.A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India, 1987.
   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]
2. S. Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi, 2005.
   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)

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

Course Outcomes:
On successful completion of the course, the student will be able to:
CO1: Apply the fundamental concept of ordinary and partial differential equation to
   a. demonstrate their understanding of how physical phenomena are modeled by second order differential equations and dynamical systems;
   b. 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.

Outcome Mapping:

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

Semester-VII **19IMAT74: Differential Geometry** **Credits: 5**

Hours: 5

Learning Objective (LO): To introduce space curves, surfaces, curves on surfaces and study some of their properties. To study the notion of geodesic and its properties. To understand some type of special surfaces such as developables and minimal surfaces.

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:
T.J. Willmore, Content and treatment as in the book An Introduction to Differential Geometry, Oxford University Press, New Delhi, 1959.
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. D.T. Struik, Lectures on Classical Differential Geometry, Addison-Wesley Press, 1950.
2. Andrew Pressley, Elementary Differential Geometry, Springer, 2001.
3. Heinrich W. Guggenheimer, Differential Geometry, Dover publications, Inc., New York, 1977.

Course Outcomes:
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.

Outcome Mapping:

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

Semester-VIII 19IMAT81: Advanced Abstract Algebra – II Credits: 5

Hours: 5

Learning Objective (LO): This course aims to provide a continuation of Advanced Abstract Algebra-I. 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.

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:

David S. Dummit and Richard M. Foote, Abstract Algebra, (Third Edition), Wiley Student Edition (2004).
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. I.N. Herstein, Topics in Algebra, John Wiley & Sons (Second Edition), New Delhi, Third Reprint 2007.
2. N. Jacobson, Lectures in Abstract Algebra, Vol. I D. Van Nostrand Co., New York, 1951.
3. M. Anderson and T. Feil, A First Course in Abstract Algebra – Rings, Groups, and Fields, Chapman & Hall/CRC, 2005.
4. M. Artin, Algebra, Pearson, 2015.

Course Outcomes:
Students will be introduced to and have knowledge of many mathematical concepts
CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving

studied in Abstract Algebra such as
- Rings,
- Irreducibility,
- Modules, a generalization of vector spaces,
- Fields.

Outcome Mapping:

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

PO														
CO1	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-
CO2	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-
CO3	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-

Semester-VIII **19IMAT82: Measure Theory and Integration** **Credits: 5**
Hours: 5

Learning Objective (LO): The concept of Lebesgue measure is introduced. Measure space and integration with respect to a measure are introduced. Convergence in measure and properties of L^p space are discussed.

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

Text Book:
G. de Barra , Contents and treatment as in the book Measure Theory and Integration, New Age International Publishers, 2005.
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.

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

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

CO1:	examples and counter examples
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.

Outcome Mapping:

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

Semester-VIII **19IMAT83: Advanced Complex Analysis** **Credits: 5**
Hours: 5

Learning Objective (LO): This course aims to train the students to get essential knowledge in functions of a complex variable. Analytic functions and their properties, Residue theorem and its applications, Riemann mapping theorem are discussed in detail.

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 behavior 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:

L.V. Ahlfors, Content and treatment as in the book Complex Analysis, (Third edition), McGraw Hill Inc., New Delhi, 2014.

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. J.B. Conway, Functions of One Complex Variable by Springer-Verlag, 1973.
2. H. Silverman, Complex Variables, Hughton Miffin Company,1975.

3. S. Ponnusamy, Foundations of Complex Analysis, (Second edition), Narosa, 2005.
4. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, McGraw Hill Education (India) Edition 2014.

Course Outcomes:

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.

Outcome Mapping:

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

Semester-VIII **19IMAP84: C++ Computer Practical** **Credits: 4**
Hours: 2

Learning Objective (LO): The objective are acquire the practical knowledge to solve problems including the fields of optimization, number theory and matrix theory.

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:

Content and treatment as in relevant sections of the following books:

1. Hamdy A. TAHA, Operations Research – An Introduction by Macmillan Publishing Company, New York, 2014.
2. Ivan Niven, Herbert S.Zuckerman and Hugh L. Montgomery, An Introduction to the theory of Numbers, Wiley, New Delhi, 2015.
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, New Delhi, 40th Edition, 2014.

Supplementary Reading:
Premkumar Gupta and D.S.Hira S.Chand, Operations Research, New Delhi,2016.

Course Outcome:
By the end of the course,
CO1: the students will be able to gain knowledge between theory and practical.

Outcome Mapping:

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

Semester-IX **19IMAT91: Topology** **Credits: 5**
Hours: 3

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

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:
James R. Munkres, Content and treatment as in the book Topology, Prentice Hall of India, (Second edition), New Delhi, 2000.
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.

Supplementary Reading:
1. S.T. Hu, Elements of General topology, Holden-Day Inc, San Francisco, 1964.
2. J.G. Hocking and G.S. Young, Topology, Addison-Wesley Pub. Com, 1961.
3. G.F. Simmons, Introduction to Topology and Modern analysis, McGraw Hill International Edition, Singapore, 1963.
4. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing house, 2005.

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

CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving

studied in Topology such as

- Connectedness
- Compactness
- Completeness

which are studied in Real Numbers.

Outcome Mapping:

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

Semester-IX **19IMAT92: Linear Algebra** **Credits: 5**
Hours: 4

Learning Objective (LO): 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. Applying principles of matrix algebra to linear transformations, double dual, commutative rings, Characteristic values, Annihilating polynomials and Decompositions of Invariant Direct sums are studied.

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:
Kenneth Hoffman and Ray Kunze, Linear Algebra, Second Edition, Prentice – Hall of India Private Limited, New Delhi ,1971.
Chapters 1 to 3, Chapter 5 (5.1 to 5.4) and Chapter 6.

Supplementary Reading:
1. I.N. Herstein,Topics in Algebra, John Wiley & Sons (Second Edition), New Delhi, Third Reprint, 2007.
2. Rao, A.R. and Bhimasankaram, P. , Linear Algebra, Second Edition, TRIM series 19, Hindustan

Book Agency, 2000.
3. Charles W. Curtis, Linear Algebra – An Introductory Approach by Springer, 1984.
4. W. Keith Nicholson, Linear Algebra with Applications, Fifth Edition, Mc Graw Hill, 2006.

Course Outcomes:

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

CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving

studied in Linear Algebra such as

- Systems of linear Equations,
- The algebra of linear transformations,
- Determinant functions,
- Diagonalization,
- Decompositions.

Outcome Mapping:

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

Semester-IX **19IMAT93: Probability Theory** **Credits: 5**
Hours: 4

Learning Objective (LO): 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.

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:

K.L. Chung, Content and treatment as in the book A Course in Probability Theory, Academic Press, Second Edition, 1974.

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. B.R. Bhat, Modern Probability Theory, New Academic Science, UK, 2018.
2. Sheldon M. Ross, A first Course in probability, 8th Edition, Pearson Education, Ltd, London, 2010.
3. C.W. Burril, Measure, Integration and Probability, McGraw Hill. 1972.

Course Outcomes:

By the end of the course, students will be able to gains
CO1: knowledge related to probability problems
CO2: a basic knowledge for studying advanced courses in this area like stochastic processes.

Outcome Mapping:

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

Semester-IX 19IMAT94: Numerical Methods Practical (Using C++ language) Credits: 2 Hours: 4

Learning Objective (LO): The objectives are acquire the practical applicability of C++ Programming to some of the problems in numerical mathematics.

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:

E.V. Krishnamoorthy and S.K. Sen, Content and treatment as in relevant sections of Numerical Algorithms, Affiliated East West Press Pvt. Ltd., (Second Edition), 1996.

Course Outcomes:

By the end of the course:
CO1: students will be able to gain knowledge between theory and practical.

Outcome Mapping:

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

Semester-X **19IMAT101: Functional Analysis** **Credits: 4**
Hours: 4

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

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:
G.F. Simmons, Content and treatment as in the book Introduction to Topology and Modern Analysis, McGraw Hill Book Company, 2015.
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.

Supplementary Reading:
1. B.V. Limaye ,Functional Analysis, Prentice - Hall of India, New Delhi, 1996.
2. Bachmann and Narishi, Functional Analysis, Academic Press, 2000.
3. Karen Saxe, Beginning Functional Analysis, Springer, 2002.
4. C. Goffman and G. Padrick, A First Course in Functional Analysis by Chelsea Pub.,1974.

Course Outcomes:
In the board field of topology, students gaining knowledge related to
CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving
in Banach space, Hilbert space and spectral operator theory.

Outcome Mapping:

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

CO2	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-
CO3	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-

Semester-X **19IMAT102: Stochastic Processes** **Credits: 4**
Hours: 4

Learning Objective (LO): The objectives are to (i) acquire the skill of advanced level of mathematical sophisticaition 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.

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:
J. Medhi, Content and treatment as in the book Stochastic Processes, New Age International (P) Limited, Publishers, New Delhi, (Second Edition), 1994.
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.

Supplementary Reading:
1. S. Karlin and H.M. Taylor, A First Course in Stochastic Processes, Academic Press (second edition), New York, 2011.
2. S.M. Ross, Stochastic Processes, Wiley India Pvt., Ltd., 2nd Edition, 2008.

Course Outcomes:
By the end of the course, students will be able to gains
CO1: working knowledge related to the problems of uncertainty.
CO2: a basic knowledge for doing research in this area.

Outcome Mapping:

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

CO2	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓

Semester-X **19IMAT103: Fluid Dynamics** **Credits: 4**
Hours: 4

Learning Objective (LO): 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.

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:
F. Chorlton, Content and treatment as in the book Fluid Dynamics, CBS Publication, New Delhi, 1985.
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.

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

Course Outcomes:
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.

Outcome Mapping:

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

Semester-X **19IMAT104: Graph Theory** **Credits: 4**
Hours: 4

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

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

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 – K_5 and $K_{3,3}$ are Nonplanar graphs – Dual of a Plane Graph – The Four Color Theorem and the Heawood Five-Color Theorem – Hamiltonian plane graphs.

Text Book:
R. Balakrishnan and K. Ranganathan, A Textbook of Graph Theory (Universitext), Second Edition, Springer, New York, 2012.
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. J.A. Bondy and U.S.R. Murty, Graph Theory, Springer 2008.
2. Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi-2011.
3. G. Chartrand, Linda Lesniak and Ping Zhang, Graphs and Digraphs, Fifth Edition, CRC press 2011.

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

CO1: examples and counter examples
CO2: proof techniques
CO3: problem solving
CO4: applications

studied in Graph Theory such as

- Trees,
- Connectivity,
- Euler tours,
- Hamilton cycles,
- Matchings,
- Colourings,
- Planar graphs

Students will be able to solve problems that can be modeled as graphs.

Outcome Mapping:

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

Semester-X 19IMAT105: Calculus of Variations and Integral Equations Credits: 4 Hours: 4

Learning Objective (LO): The aim of the course is to introduce to the students the concept of calculus of variations and its applications. Various types of integral equations have been introduced and method of solving these equations are given.

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:
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, Linear Integral Equations Theory and Practice, Academic Press 1971.
2. L.Elsgolts, Differential equations and the calculus of variations, University Press of the Pacific, 2003.
3. S.J.Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.
4. I.N.Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.
5. Lev D. Elsgole, Calculus of Variations, Dover Publications Inc, New York 2007.
6. Integral Equations and their Applications, M.Rahman WIT Press, Boston, 2007.

Course Outcomes:

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 inhomogeneous etc.

CO2: They will have a much better understanding of the fundamental concepts related to the space of admissible variations and concepts of a weak and a strong relative minimum of an integral.

Outcome Mapping:

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

Elective Courses (DE):

Semester-VIII **19IMAT86-1: Programming Language C++** **Credits: 3**
Hours: 3

Learning Objective (LO): The language C++ is a Object Oriented Programming Language. First the syntax of the language C++ is introduced. This is followed by Control statement, Arrays, Functions, Pointers, Structures and Classes. Many problems are solved after writing algorithms and programs in C++.

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:
Robert Lafore, Content and treatment as in the book Object-Oriented Programming in TURBO C++, Galgotia Publications Pvt. Ltd., New Delhi, 1996.

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

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

Outcome Mapping:

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

Semester-IX **19IMAT96-1: Number Theory** **Credits: 3**
Hours: 3

Learning Objective (LO): The prime aim of this paper is to enrich the knowledge of Number Theory. The concepts of primes, congruences, prime power moduli, power residues, quadratic

residues, greatest integer function, Mobius inversion formula are introduced. Diophantine equations and their positive solutions are discussed. Simple continued functions are also considered.

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:
Ivan Niven, H.S. Zuckerman and Hugh L. Montgomery, Contents and treatment as in the book An Introduction to the Theory of Numbers, Fifth Edition, Wiley Eastern Limited, New Delhi, 1991.

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

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

CO1: examples and counter examples
CO2: Proof techniques
CO3: problem solving of

- Divisibility relation,
- Congruence relation,
- Special number theoretic functions,
- Diophantine equations and
- Algebric numbers.

Outcome Mapping:

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

Semester-IX **19IMAT96-2: Fuzzy Sets and their Applications** **Credits: 3**
Hours: 3

Learning Objective (LO): This course aims to offer fuzzy sets, fuzzy relations, fuzzy logic, fuzzy composition and applications.

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:
G.J. Klir and Bo Yuan, Content and treatment as in the book Fuzzy Sets and fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd., New Delhi, 2005.

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

Course Outcomes:
On successful completion of the course, the student will be able to identify the basic concepts
CO1: examples and counter examples
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.

Outcome Mapping:

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

Electives for other Department students:

Semester- VIII **19MATE815.1: Discrete Mathematics** **Credits: 3**
Hours: 3

Learning Objective (LO): Students must understand mathematical reasoning in order to read, comprehend and construct mathematical arguments. Mathematical logic, which serves as foundation for subsequent discussion is discussed. Discrete structures such as sets and permutations are studied. Discrete probability, recurrence relations, conquer relations and principles of inclusion and exclusion are studied.

Unit-1: Logic and Counting:
Propositions and logical operations, Conditional statements, Methods of Proof, Mathematical Induction. Permutations, Combinations, Pigeonhole Principle, Elements of Probability, Recurrence Relations.

Unit-2: Relations and Digraphs:
Product sets and partitions, Relations and Digraphs, Paths in Relations and Digraphs, Properties of relations, Equivalence Relations, Computer Representation of Relations and Digraphs, Operations on Relations, Transitive Closure and Warshall's Algorithm.

Unit-3: Functions:
Functions, Functions for Computer Science, Growth of Functions, Permutation Functions.

Unit-4: Order Relations and Structures:
Partially Ordered Sets, Extremal Elements of Partially Ordered Sets, Lattice, Finite Boolean Algebras, Functions on Boolean Algebra, Circuit Designs.

Unit-5: Semigroups and Groups:
Semigroups, Product and Quotient of Semigroups, Groups, Product and Quotient of Groups.

Text Book:
Bernard Kolman, Robert C. Busby and Sharon Cutler Ross, Content and treatment as in the book Discrete Mathematical Structures, Prentice - Hall of India, Private Limited, New Delhi, 2002.

Unit I Chapter 2 Sections 1 to 4,
Chapter 3 Sections 1 to 5.
Unit II Chapter 4 Sections 1 to 8.
Unit III Chapter 5 Sections 1 to 4.
Unit IV Chapter 6 Sections 1 to 6.
Unit V Chapter 9 Sections 1 to 4.

Supplementary Reading:
1. E.G. Goodaire and M.M. Paramenter, Discrete Mathematics with Graph Theory, Prentice Hall International Editions, New Jersey (1998).
2. J. Matonsek and J. Nesetril, Invitation to Discrete Mathematics by Clarendon Press, Oxford (1998).
3. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill Publication Company, 1997.

Course Outcomes:
Every student shall get a good exposure in
CO1: examples and counter examples
CO2: Proof techniques
CO3: problem solving

CO4: applications

of various concepts in: Logic and Counting, Relations and Digraphs, Functions, Order Relations and Structures and Semigroups and Groups.

Outcome Mapping:

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

Semester-VIII **19MATE815.2: Numerical Methods** **Credits: 3**
Hours: 3

Learning Objective (LO): The roll of numerical analysis is to develop and analyze the numerical techniques. In this paper, different methods for finding the roots of algebraic and transcendental equations, solutions of simultaneous equations, solutions of differential equations are concentrated. Numerical differentiation and integration are also evaluated.

Unit-1: The solution of Numerical Algebraic and Transcendental Equations:
Introduction, The Bolzano's bisection method, Method of successive Approximations or the iteration method, The method of false position (Regula Falsi Method), Newton's iteration Method (Newton - Raphson method).

Unit-2: Simultaneous Linear Algebraic Equations:
Gauss Elimination method, Computation of the inverse of a matrix using Gauss elimination method, Method of Triangularisation (Method of Factorization), Crout's method, Iterative methods, Jacobi method of iteration (Gauss-Jacobi Method), Gauss Seidal method of iteration.

Unit-3: Interpolation:
Introduction, Linear interpolation, Gregory Newton Forward and Backward interpolation Formula, Equidistant terms with one or more missing values.

Interpolation with unequal intervals:
Divided Differences, Properties of Divided differences, Newton's interpolation formula for unequal intervals, Lagrange's interpolation formula, Inverse interpolation.

Unit-4: Numerical Differentiation and Integration:
Introduction, Newton's forward difference formula to compute the derivatives, Newton's backward difference formula to compute the derivatives, Derivatives using Stirling's formula.
Trapezoidal rule, Simpson's rule, Practical applications of Simpson's rule, Trapezoidal rules.

Unit-5: Numerical Solution of Ordinary Differential Equations:
Euler's method, improved Euler method, modified Euler method, Runge-Kutta methods, Second order Runge-Kutta Method, Higher order Runge - Kutta method.

Text Book:
M.K. Venkataraman, Content and treatment as in the book Numerical Methods in Science and Engineering, The National Publishing Company, Madras, 1991.
Chapters - III, IV, VI, IX, XI.

Supplementary Reading:
1. S.S. Sastry, Introductory Methods of Numerical Analysis by Prentice Hall of India (P) Ltd. 1994.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern Ltd., Third Edition, 1993.

Course Outcomes:
Every student shall get a good exposure in
CO1: examples and counter examples
CO2: problem solving
CO3: applications

of various concepts in: obtaining numerical solutions of Algebraic, Transcendental and Ordinary Differential Equations.

Outcome Mapping:

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

Semester-IX **19MATE915.1: Differential Equations** **Credits: 3**
Hours: 3

Learning Objective (LO): This course aims to provide logical skills in the formation of differential equations, to expose to different techniques of finding solutions to these equations and in addition stress is laid on the application of these equations in geometrical and physical problems. It also aims to provide logical skills in the formation and solutions techniques of partial differential equations.

Unit-1: Ordinary Differential Equations:
Bernoulli Equation – Exact Differential Equations – Equations Reducible to Exact Equations – Equations of First order and Higher degree: Equations solvable for p, Equation solvable for x and Equations Solvable for y – Clairaut's Equation.

Unit-2: Ordinary Differential Equations [Contd...]:
Method of Variation of Parameters – 2nd order Differential Equations with Constant Coefficients for finding the P.I's of the form eax V, where V is sin(mx) or cos(mx) and xn.

Unit-3: Laplace Transform:
Laplace Transform, Inverse Laplace transform, Application to the first and second order linear differential equations.

Unit-4: Partial Differential Equations:
Partial differential equations: Formation of P.D.E. by eliminating arbitrary constants and arbitrary functions, Complete, Singular and General integral. Solution of equations of standard types: f(p,q)=0, f(x,p,q)=0, f(y,p,q)=0, f(z,p,q)=0, f(x,p)=f(y,q), and Clairaut's form. Lagrange's equation Pp+Qq=R, Simple problems.

Unit-5: Series Solution:
Series solutions of first order equations, Second order linear equations, Ordinary points, Regular Singular Points

Text Books:
Content and treatment as in the following books:

1. P.R. Vittal, Differential Equations, Fourier and Laplace Transforms, Margham publications, Second Edition, 1999.
   - Unit I - Chapter 1 1(A) & 1 (B)
   - Unit II - Chapter 2 2.10 to 2.32
   - Chapter 3 3.15 to 3.23
   - Unit III - Chapter 7 except simultaneous equations
   - Unit IV - Chapter 5.
2. George F. Simmons, Differential equations with applications and historical notes, Tata McGraw Hill Pub. Co., New Delhi, Second Edition, 2003.
   - Unit V - Chapter 5 Sections 26 – 29

Supplementary Reading:

1. M.D. Raisinghania and R.S. Aggarwal, Ordinary and partial Differential equations, Sultan Chand and Company Ltd., 1983.

2. M.D. Raisinghania, Ordinary and Partial Differntial Equations, S. Chand, 2006
3. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, [2002], New Delhi.

Course Outcomes:

At the end of the course the students will able to get

CO1: the skill of the formation of differential equations and partial differential equations.

CO2: the skill to expose different techniques of finding solution of differential equations and partial differential equations.

Outcome Mapping:

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

Value Added Course:

Semester- **VAC: Mathematics For Competitive Examinations** **Credits: 3**
Hours: 3

Learning Objective (LO): To introduce concepts of mathematics with emphasis on analytical ability and computational skill needed in competitive examinations.

Unit-1: Problems on General Arithmetic:

Problems of ages – Ratio and proportions -Inverse ratio-properties (Addendo, subtrahendo, componendo & dividendo) -ratio of four numbers -increasing and decreasing order of fractions.

Unit-2:

Percentages - Gain and loss percents - Partnership problems.

Unit-3: Time, Distance and Work:

Time and work – Time and distance.

Unit-4: Commercial Arithmetic:

Simple interest - Compound interest – Stocks and Shares.

Unit -5: Data Interpretation:

Tabulation – Bar graphs and Pie charts – Line Graphs.

Text Book:

R.S. Agarwal, Content and treatment as in the book Quantitative Aptitude, S. Chand & Co, New Delhi, 2015.

Unit – I	Sections 1.8 and 1.12
Unit – II	Sections 1.10, 1.11 and 1.13
Unit – III	Sections 1.15 and 1.17
Unit – IV	Sections 1.21, 1.22 and 1.29
Unit – V	Sections 2.36 to 2.38

Supplementary Reading:

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Tata McGraw –Hill Pub. Co. Ltd. New Delhi, IV Edn., 2011.
2. Edgar Thorpe, Course in Mental Abilities and Quantitative Aptitude for Competitive Examinations, Tata McGraw Hill Pub. Co. Ltd. New Delhi, II Edn., 2008.
3. RSN Pillai and A. Bagavathi, Statistic, S.Chand & Co., 7th Revised Edition, 2008.

Course Outcome:

By the end of the course, students will be able to face the Mathematics part of competitive examinations easily.