Department of Mathematics

(AFFILIATED COLLEGES)

PONDICHERRY UNIVERSITY

UG Degree (BS Honours) with Research in Mathematics

NATIONAL EDUCATION POLICY (NEP 2020) REGULATIONS-2023

ACADEMIC YEAR 2025-2026 ONWARDS

1. Definitions:

Terms used in the NEP-CBCS Regulations shall have the meaning assigned to them as given below, unless the context otherwise requires:

a. **Credit:** A credit is the number of hours of instruction required per week for the given subject in a given semester of 16-18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice or fieldwork or community engagement, and service per Semester.

b. **Academic Year**" means the year starting on the 1st day of July and ends on the 30th day of June succeeding year.

c. "**Residence time"** means the time a student spends attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.

d. "**Semester**" means 18 weeks (90 Working days) of teaching-learning session, of which two weeks shall be set apart for exaTOPminations and evaluation;

e. "**Grade**" means a letter grade assigned to a student in a Course for his performance at academic sessions as denoted in symbols of: O(outstanding), A+(Excellent), A (Very good), B+ (good), B (Above average), C (average), P (Pass) F (fail) and Ab (Absent) with a numeric value of O=10, A+=9, A=8, B+=7, B=6, C=5 P=4, and F=0, Ab=0;

f. "**Grade Point Average (GPA)**" means an average of the Grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses;

g. **"Cumulative GPA (CGPA)**" is the weighted average of all courses the student has taken in a given Programme;

h. "**A common Course**" means the set of courses that all students who are admitted to any Programme of the University are required to study; these courses include, Languages (English-modern Indian languages), NEP specific courses- viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, Digital & Technological solutions;

i. **"Major Discipline"** means the core subject mandatory for the programme, Major discipline may be a single discipline or interdisciplinary/ multidisciplinary courses. Eg. B.Sc. (Maths) or B.Sc. (Maths and Chemistry)

j. **"Minor Discipline"** means allied or elective subjects to major discipline.

(i) **"Minor discipline Cognate"** refers to a pool of courses offered by the parent department/ cognate (allied) departments. Eg. B.Com(General) may have minors streams leading in 2/3 to B.Com (Accounting

& Taxation), B.Com(Banking&Finance), B.Com(Company Law & Corporate Secretaryship) or B.Com(Computer app and Data Analcs)

(ii) "**Minor discipline Generic"** refers to the subsidiary/elective subjects chosen from a basket of courses offered by different departments other than the minors offered by the parent department. Eg. B.Com. (Corporate Economics)

k. "**Credit Requirement**" for a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be;

l. "**Exit option**" means the option exercised by the students, to leave the Programme at the end of any given Academic year; "**Lateral entry**" means a student is admitted into an ongoing Programme of the University otherwise than in the 1st year of the programme.

m. "Vocational Studies/Education" This refers to a set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc

n. Skill-based learning/project: This refers to activities designed to understand the different socio-economic contexts, a first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.

o. Work-based internship - This refers to structured internships with local industries, businesses, artists, crafts persons, etc., which will further improve employability.

2. Programme Outcomes

Upon successful completion of the Bachelor of Science (B.Sc.) program in Mathematics students will achieve the following outcomes:

UG Certificate Level

- Mathematical Foundation: Develop a strong understanding of fundamental concepts in Mathematics, emphasizing its theoretical and applied aspects.
- Introductory Skills in Data Science: Gain exposure to Python and R programming and problem-solving techniques relevant to Data Science.

UG Diploma Level

- Programming Competence: Develop practical programming skills and gain hands-on experience with data analysis using computational tools.
- Integration of Disciplines: Familiarize with computational techniques and their applications in Mathematics and Data Science.

UG Degree Level

- Applied Mathematics: Utilize advanced mathematical methods to tackle real-world problems.
- Multidisciplinary Applications: Apply mathematical modeling in solving challenges across various domains.

UG Degree with Honors / Honors with Research

- Mathematical Research: Acquire the ability to conduct mathematical research, contributing to innovations in applied mathematics and related fields.

- Insightful Communication: Excel in articulating complex mathematical and data-driven findings through detailed reports, data visualizations, and professional presentations.

3. DURATION, ELIGIBILITY & AWARD OF UG DEGREE/DIPLOMA/CERTIFICATE

3.1. Duration of the Programme

The duration of the UG programme is 4 years or 8 semesters. Students who desire to undergo a Three-year UG Programme will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits (as given in table below).

3.2. Eligibility

Senior Secondary School Leaving Certificate or Higher Secondary (12th Grade) Certificate obtained after successful completion of Grade 12 or equivalent stage of education corresponding to Level 4 (Levels in NHEQF). For detailed eligibility conditions , refer the Admissions and Lateral Section below.

3.3. Awarding of UG Certificate, UG Diploma and Degrees Nomenclature

Four years B.Sc. Degree Programme shall have options for earning a Certificate / Diploma / UG Degree / UG Degree (Honors) / UG Degree (Honors with Research) based on the exit option exercised by the candidates.

3.3.1. UG Certificate

Students who opt to exit after completion of the first year (2 Semesters) and have earned a minimum of 40 credits will be awarded a UG certificate in Mathematics if, in addition, they complete work based vocational course / internship of 4 credits during the summer vacation of the first year.

3.3.2. UG Diploma

Students who opt to exit after completion of the second year (4 Semesters) and have earned a minimum of 80 credits will be awarded the UG diploma in Mathematics if, in addition, they complete work based vocational course / internship of 4 credits during the summer vacation of the second year.

3.3.3. Three-year UG Degree

Students who wish to discontinue after the 3-year (6 Semesters) UG programme will be awarded a UG Degree in Mathematics after successful completion of three years, earning a minimum of 120 credits and satisfying the minimum credit requirements as mentioned in Table1 below.

3.3.4. Four-year UG Degree (Honors)

A four-year UG Honors degree in Mathematics will be awarded to those who complete a four-year (8 Semesters) degree programme, earning a minimum of 160 credits and have satisfied the credit requirements as mentioned in Table 1.

3.3.5. Four-year UG Degree (Honors with Research)

Students who secure a minimum of 6 CGPA in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a faculty member of the Institution.

The research project/dissertation will be in the major discipline. The students who secure a minimum of 160 credits, including 12 credits from a research project/dissertation, will be awarded a UG Degree in Mathematics (Honors with Research).

3.3.6. Programme overview

As per the guidelines of NEP, students are mandated to complete 120 credits to complete a basic Bachelor's Degree in 3 years. With an additional 40 credits of course work one can pursue 4th Year Honors or Honors with Research Degree. The UG Programme will consist of the following categories of courses and the minimum credit requirements for 3-year UG and 4-year UG(Honors) or UG (Honors with Research) programmes are given below.

Table.1 Breakup of Credits and Courses – Minimum Requirements

BREAKUP OF CREDITS AND COURSES			
Sl.No.	**Component**	**3 Year Degree**	**4 Year Hons Degree**
1	Major Disciplinary Courses	60 Credits (15 Courses of 4 credits each)	80 Credits (20 Courses of 4 credits each)
2	Minor Discipline Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 credits each)
3	Multi-Disciplinary Courses	9 Credits(3 courses of 3credits each)	9 Credits (3 courses of 3 credits each)
4	Ability Enhancement Courses	8 Credits(4 courses of 2 credits each)	8 Credits (4 courses of 2 credits each)
5	Skill Enhancement Course	9 Credits(3 courses of 3 credits each)	9 Credits (3courses of 3 credits each)
6	Common Value added courses	8 Credits(4 course of 2 credits each)	8 Credits (4 course of 2 credits each)
7	Community Science	2 Credits(1 field based course)	2 Credits (1 field based course)
8	Research Dissertation Project	-	12 Credits(Project report & background subjects)
9	Total credits required	120 Credits	160 Credits

Note: Honors students not undertaking research will do 3 courses for 12 credits in lieu of a Research Project / Dissertation.

3.3.7. Degree and Nomenclature

Candidates who complete Eight semesters earn a minimum of 160 credits and have satisfied the credit requirements as mentioned in the table below will be awarded either of the following degrees.

1. B.Sc. Mathematics
2. B.Sc. Mathematics (Honors)#
3. B.Sc. Mathematics (Honors with Research)##

for candidates who complete 3 theory courses (MJD 21, MJD 22, and MJD 23) instead of the research project work in the Eighth Semester.

for candidates who complete a research project work in the Eighth Semester

3.3.8. Exit Options and Nomenclature of Certificate, Diploma

Candidates can exercise the following exit options and obtain the said certificate or diploma or degree, if the minimum required credits are earned and other conditions are met. Students exercising the option of exit at the end of 2nd semester or 4th semester need to have completed an internship for atleast 8 weeks along with the necessary credit requirements to qualify for the relevant certificate or diploma. In any case, every student, whenever exit (or complete the 4 year programme), should have completed atleast one internship for a minimum period of 8 weeks.

Exit after 2nd Semester: Certificate in Mathematics will be awarded for candidates who exit the course at the end of 2nd semester and earned a minimum of 40 credits and have completed a Summer Internship of 4 credits for a minimum period of 8 weeks, during the summer vacation post 2nd semester.

Exit after 4th Semester: Diploma in Mathematics will be awarded for candidates who exit the course at the end of 4th semester and earned a minimum of 80 credits and have completed a Summer Internship of 4 credits for a minimum period of 8 weeks, during the summer vacation post 4th semester.

Exit after 6th Semester: UG Degree in Mathematics (B.Sc. (Mathematics)) will be awarded for candidates who exit the course at the end of 6th semester and earned a minimum of 120 credits and have completed a Summer Internship of 4 credits for a minimum period of 8 weeks, during the summer vacation post 4th semester.

Exit after	Credits and other requirements	Awards
2nd Semester	Min: 40 Credits & Internship	Certificate in Mathematics
4th Semester	Min: 80 Credits & Internship	Diploma in Mathematics
6th Semester	Min: 120 Credits & Internship	B.Sc. Mathematics

4. NEP Classification of Courses:

i) Major Disciplinary courses (MJD): (60/80 credits)

Major disciplinary courses are subject specific compulsory subjects that a student has to complete to obtain the UG/UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits.

All discipline specific major courses shall be designed for 4 credits each with one/two additional hours or guidance of teaching at Tutorials/Practicals.

UG programmes may be offered in a single major discipline or in Multiple Major disciplines giving equal weightage in credits. For example a B.Sc. course may be in a single discipline like B.Sc. (Maths) or with multiple major disciplines like B.Sc. (Maths, Data science, Statistics).

ii) Minor Disciplinary Course (MID): (24/32 credits)

Minor disciplinary courses refer to those subjects which are Allied/Specialization/Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. Minor disciplinary courses(MID) may also be designed by the parent department or collaborated with sister departments. Parent departments may introduce minor specializations to students by offering a set of 6 to 8 courses in one/two streams as electives or specialization subjects. In order to provide students with a choice of particular specialization/elective, the BOS may develop 2 to 3 streams of minor specialization courses to focus on such trades for better placement of students. Each stream of 6/8

specialization/elective subjects may facilitate the award of two/three unique degrees in a given major Eg, B.Sc. (Physical Chemistry), B.Sc. (Pharmaceutical Chemistry), etc.

iii) Multi-Disciplinary courses (MLD): (9 Credits)

All undergraduate students must pursue 9 credits worth of courses in such Multi-disciplinary areas/Courses from NEP-defined subjects. Colleges may identify any 3 multiple-disciplinary streams listed below based on the availability of resources and manpower.

a) Natural Sciences
b) Physical Sciences
c) Mathematics & Statistics
d) Computer Science/Applications
e) Data Analysis
f) Social Sciences
g) Humanities
h) Commerce & Management
i) Library Science
j) Media Sciences, etc.

Students are expected to learn basic/introductory courses designed by other departments for this purpose. Colleges may list any 3 introductory courses (one each in Natural Sciences, Physical Sciences, Humanities) for uniform adoption of all UG students.

iv) Ability Enhancement (AEC) courses: (8 Credits)

All Undergraduate (UG) students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, and writing skills. These courses are expected to enhance the ability in articulate and presentation of their thoughts at the workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline.

v) Skill Enhancement Course: (9 Credits)

Ability Enhancement Course	
I. English Language (two courses)	**II. Indian Language (two courses)**
a) English Language & Literature 1 and 2 b) Functional English – 1 and 2 c) Communicative English – 1 and 2	a) Indian language & Literature 1 and 2 b) Functional language – 2 c) Communicative language – 1 and 2

These courses focus at imparting practical skills with hands-on Training. In order to enhance the employability of students, Colleges are expected to design such courses that they deem fit for their students for better employment/entrepreneurship/career development, etc. Colleges may also outsource the Skill Enhancement Courses to AICTE approved agencies for conducting short term Training Workshops, Skill India initiatives of GOI and approved Trades by Skill development of corporation are to be considered. short term courses.

vi) Value Added Common courses (VAC): (8 credits)

Under NEP, the UGC has proposed for 6 to 8 credits worth of common courses which are likely to add

value to overall knowledge base of the students. These courses include:

a) Understanding India
b) Environmental Science/Education, Higher Order Thinking
c) Digital and Technological solutions
d) Health &Wellness, Yoga Education, Sports & Fitness, Universal Human Values

The course structure and coverage of topics are suggested by UGC in its draft documents; colleges/UG Boards of Studies may design the methodology for conducting these value-added courses.

vii) Community Engagement and Service (CES) (2 credits)

All UG students are also mandated to participate in a 15-day community engagement activity during their winter vacation between the 5th and 6th Semesters. This Community engagement activity is expected to expose the students to the social problems of the neighborhood village. students may prepare a report on the activities carried out for an award of 2 credits.

viii) Summer Internship (2 to 4 Credits)

As per the UGC guidelines, all UG students should be exposed to a 4 to 6-week Summer Internship in an industrial organization/Training Centers/Research Institution, etc. Such a Summer Internship is to be conducted between the 4th and 5th semesters. A review of the report and award of grade based on work-based learning by students is to be recorded during the 5th Semester.

ix) Research Project (12 Credits)

All UG (Hons) Degree students are expected to conduct a semester long Research work - during their 8th Semester and submit a Research Report. Students may be given necessary guidance by faculty members in identifying the research problem, conduct of study and preparation of a Project Report. All these Research Reports are evaluated by a Jury of external experts. A presentation of Results and Viva may also be part of evaluation. A Publication out of findings of the Research Project may also be encouraged.

Levels of Courses:

The levels are:

0 to 99 = Pre requisite/ Bridge courses
100 to 199 = Foundation courses/Introductory courses
200 to 299 = Intermediate Level courses
300 to 399 = Core courses/Advanced courses
400 and above = Specialization subjects

Semester -wise Break up of Courses for 3 year UG and 4 Year UG (Hons) Degree programmes

Incorporating the focus of NEP in terms of different categories of courses and award of Certificates, Diplomas and Degrees during different stages of 4 year Degree programmes, a template for Semester-wise course work was designed by the UGC and presented in para 5.3 of "Curriculum Framework". Salient features of it are as follows:

- Every Semester shall have a minimum of 20 credits worth of courses.

- Credits for a course shall be decided on the basis of number of Contact hours of the teaching in a classroom. One credit means one hour of Teaching in case of Theory subject and at least 2 hours of conducting Practical in hours case of Lab subjects.
- All Major and Minor disciplinary Courses shall have 4 credits with 6 hours of work load (including 2 hours of tutorials)
- Language courses, ability enhancement, skill enhancement and value added common course also will have 2 hours of hands on training.
- Students can exercise his/her choice for exiting the course at the end of every Academic year.
- Semester I and II shall focus on introductory courses/subjects in Major/Minor disciplines and shall focus on providing knowledge in Multidisciplinary areas, skill enhancement and ability enhancement courses.
- Semester III and IV shall focus on Core disciplinary courses with a focus on building strong foundation in the given Discipline.
- Semester V and VI shall focus on providing in-depth knowledge and skills required for taking up a career in the given discipline.
- Semester VII and VIII shall focus on Advanced knowledge and shall direct the students to take up socially relevant projects/Research works newer applications of the knowledge.
  While directing the above mentioned requirements, UGC has designed a Template for each Semester.

Eligibility:

All students who have completed their Higher Secondary School Certificate are eligible for admission into an undergraduate degree programme, subject to securing m50% of marks at 12th standard with a minimum of 50% of marks with Mathematics or equivalent stage of education to Level-4 (Levels in NHEQF).

Admissions:

As per the NEP, students shall be admitted to Undergraduate Programmes on basis of merit order in an All India Admission Test like CUET, NEET, etc. However, the respective State/UT Governments shall decide the order of merit for admission of students for different courses offered at Colleges.

Lateral Entry:

As per NEP, students have a choice of exit and entry into the Programme of Study multiple number of times. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students. Detailed guidelines for lateral Entry would be finalized by the University shortly.

PONDICHERRY UNIVERSITY

NEP

SEMESTER WISE COURSE STRUCTURE FOR UG AND UG (HONS) COURSES

ANNEXURE - I

Semester	Levels of Teaching	Major Disciplinary Courses (Total Credits: 60/80)	Minor Disciplinary Courses (Total Credits: 24/32)	Multi-Disciplinary Courses (Total Credits: 9)	Ability Enhancement courses (Total Credits: 8)	Skill Enhancement Courses (Total Credits: 9)	Value added /Common Course (Total Credits: 8)	Total Credits
I	100 Level	MJD – I Major Disciplinary Course - 1 **4 Cr**	MID-I Minor Disciplinary Course -1 (2 to 3 stream of Minor) **4 Cr**	MLDC-I Multi-Disciplinary Course-1 Natural Sciences (3 Cr) **3 Cr**	AEC-I Ability Enhancement course English -1 (4 Hours Teaching) Language Course - 1 4 hrs of Teaching **2+1**	SKE-I Skill Enhancement Course-1 15 Practicals (3 Cr) 2 to 3 streams of Hands on Training **3 Cr**	VAC I and II NEP special common courses (two) 1. Environmental Sciences/Education (2 Cr) 2. Understanding India (2 Cr) **4 Cr**	Total courses in Semester I - 7 **20**
II	100 Level 1	MJD – 2 Major Disciplinary Course – 2 **4 Cr**	MID-II Minor Disciplinary Course -2 2 to 3 streams of minor courses **4 Cr**	MLDC-II Multi-Disciplinary Course-2 Physical Sciences **3 Cr**	AEC-II Language course-2 English - 2 (2 Cr) (4 Hrs of Teaching) **2+1**	SKE-II Skill Development Course Practicals - 2 (3 Cr) **3 Cr**	VAC III & IV NEP Special/Common courses -3,4 3. Health & Yoga (2 Cr) 4. Digital Techn (2 Cr) **4 Cr**	Total courses in Semester II - 7 **20**
Certificate for exiting students provided that they undergo 4 credits Internship during Summer Vacation in the given stream of skill training								

Semester	Levels of Teaching	Major Discipline Course (Total Credits: 60/80)	Minor Discipline Course (Total Credits: 24/32)	Multi-Disciplinary Course (Total Credits: 9)	Ability Enhancement courses (Total Credits: 8)	Skill Enhancement Courses (Total Credits: 9)	Value added /Common Course (Total Credits: 8)	Total Credits
III	200 Level	MJD – III & IV Major Disciplinary Course - 3 Major Disciplinary Course - 4 **8 Cr**	MID-III Minor Disciplinary Course -3 (Allied/Elective) (4 Cr) **4Cr**	MDC-III Multi-Disciplinary Course-3 Basics of Humanities (3 Cr) **3Cr**	AEC-III Ability Enhancement course Indian Language - 1 (4 Hours Teaching) **2+1 Cr**	SKE-III Skill Development Course Practicals (3 Cr) **3Cr**	- **0**	Total courses in Semester III - 6 **20**
IV	200 Level	Major 5 (4 Cr) Major 6 (4 Cr) Major 7 (4 Cr) **12Cr**	Minor 4 (4 Cr) **4C**	- **0**	AEC - 4 Indian Language - 2 (2 Cr) **2+1 Cr**	- **0**	Winter Project (Community engagement 15 days) **2 Cr**	Total courses in Semester IV - 6 **20**
UG Diploma in Major Disciplinary course for Exiting Students after completing 4 Cr Summer Internship for 45 Days								

Semester	Levels of Teaching	Major Discipline Course	Minor Discipline Course	Multi-Disciplinary Course	Ability Enhancement courses	Skill Enhancement Courses	Value added /Common Course	Total Credits
V	300 Level	Major 8 Major 9 Major 10 (12 cr) 12Cr	Minor 5 (4 Cr) 4Crr	- 0	- 0	Summer Internship for 60 Days (4 Cr) (Main -15) 4 Cr	- 0	Total courses in Semester V – 5 20
VI	300 Level	Major 11 Major 12 Major 13 Major 14 4*4 (16 Cr) 16Cr	Minor 6 (4 Cr) 4Crr	- 0	- 0	- 0	- 0	Total courses in Semester VI – 5 20
Total courses for a UG Degree		15 Courses 60 Cr	6 Courses 24 Cr	3 Courses 9 Cr	4 Course 8 Cr	3 Course 9 Cr	4 Course 8 Cr	Total courses for a 3 yr UG Degree 120Cr

UG Hons Degree

Semester	Levels of Teaching	Major Discipline Course (Total Credits 80)	Minor Discipline Course (Total Credits 32)	Multi-Disciplinary Course	Ability Enhancement courses	Skill Enhancement Courses	Value added /Common Course	Total Credits
VII	400	Major 16 Major 17 Major 18 (12 cr) 12	Minor 7 Minor 8 (8 Cr) 8	-	-	-	-	20
VIII	400	Major 19 Major 20 (8 cr) 8	-	Research Project (12 Cr) Research + Viva (or) 3 Additional Major Courses (3*4=12)			1	12 20
Total Course		20 courses 80 Credits	8 32	3 Course 9	4 Course 8	3 Course 4	4 Course 8	52 Course

- UG (hons) Degree by Research
- UG (hons) Degree by Coursework

EVALUATION:

Total Marks: 100:

All Credit courses are evaluated for 100 marks. Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks. In case of Practical, Project work etc., it is 50:50 marks for Internal and End-Semester Exams.

Break up of Internal Assessment marks:

Total Internal Assessment mark for a theory subject is 25 marks. The breakup is:

a)	Mid Semester Exam (one) -	20 Marks
b)	Percentage of Attendance -	5 Marks
	Total -	25 Marks

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

Internal Test Scheme:

Principal of the College schedules the Mid-Semester Exam for all courses during 8/9th week of start of classes. All faculty members are expected to conduct this Mid-Semester exam for 1.30 hr. duration and evaluate, upload the marks to Controller of Examinations of University. Colleges are also requested to preserve the answer books of Mid-Semester exams until declaration of results by the University.

Internal Assessment marks for Practicals/Project work/ Internships subjects:

The faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The break up is as follows:

a) Observation note/Demo note/Work dairy	20
b) Practical Record/Internship Report	30
Total	**50**

End-Semester University Exam:

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on University calendar. A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams mostly during 15/16th week of the Semester. Question Papers shall be set externally based on BOS approved syllabus. All students who have a minimum of 70% attendance are eligible to attend the end semester exams. The breakup of end semester marks:

a) Theory subjects (Sec A, Sec B and Sec C) Question from all units of syllabus	75 marks

b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	50 marks

QUESTION PAPER PATTTERN
MAXIMUM MARK: 75
TIME : 3 HOURS

SECTION A	SECTION B
FIVE QUESTIONS (5X5 = 25) Either Or Type Internal Choice 1 set of questions from each Unit.	**FIVE QUESTIONS** (5X10 = 50) 5 out of 8 questions 1 question from each Unit compulsory.

Section	Number of Questions	Allocation of questions	Choice Type	Mark per question	Total marks
A	5	1 set from each Unit	Either or type	5	**5X5=25**
B	5	2 questions from Unit 1 2 questions from Unit 2 2 questions from Unit 3 1 question from Unit 4 1 question from Unit 5	5 out of 8	10	**5X10=50**

Consolidation of Marks and passing Minimum

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination. The total marks will be converted into letter grades as shown in the following Table 2. As per NEP Regulations, the passing minimum is 50% marks (IA + End Semester put together) However, Pondicherry University considers 40% marks as a pass during the first 3 years of study and students who secured less than 50 will be awarded 'P' (Pass Grade)

Arrear Exam:

A student who failed to secure 50% marks in aggregate is declared as Failed and he is eligible to take up supplementary examination by registering for the said course in the following Semester. All other candidates who failed due to a shortage of attendance, and those who are seeking to improve the grade, shall repeat the course.

Letter Grades and Calculation of CGPA:

The Total Marks Secured by a student in each subject shall be converted into a letter grade. The UGC Framework has suggested a countrywide uniform letter grade for all UG courses. The following Table shows the seven letter grades and corresponding meaning, and the grade points for the calculation of CGPA.

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to work out the above letter grades, the marks secured by a student (Total of IA and Semester End) would be categorized for relative grading. The ranges of marks for each grades would be worked as follows:

Highest marks in the given subject : X

Cut of marks for grading purpose : 50 marks

Passing mark (for 3 year of UG) = 40

Number of grades (excepting P grade)(O,A+,A,B+,B,C) = 6

Range of marks = K=(x-50)/G

The following table given the range of marks and letter grades. According to K value, one of the following grading scheme will be followed.

(i) If K ≥ 5, then the grades shall be awarded as given in Table II.

Table II		
Range of Marks in %	**Letter Grade Points for**	**Letter Grade Points for**
X to (X-K)+1	O	10
(X-K) to (X-2K)+1	A+	9
(X-2K) to (X-3K)+1	A	8
(X-3K) to (X-4K)+1	B+	7
(X-4K) to (X-5K)+1	B	6
(X-5K) to 50	C	5
40 – 49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K<5, then the grades shall be awarded as given in Table III.

Table III		
Range of Marks in %	**Letter Grade Points for**	**Letter Grade Points for**
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below 40	F	0
Absent (lack of attendance)	Ab	0

Calculation of Semester Grade Point average and CGPA:

Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,

i.e., **SGPA** (Si) = Σ(Ci x Gi) / ΣCi, where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

(i) Example for Computation of SGPA (candidate not failed in any course)

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	B	6	4 X 6 = 24
		20			139
	SGPA				139/20=6.95

(ii) Example for Computation of SGPA (candidate has failed in one course.)

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			115
SGPA					115/20=5.75

(iii) Example for Computation of SGPA (candidate has failed in two courses.)

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	F	0	3 X 0 = 00
I	Course 4	3	B	6	3 X 6 = 18
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			85
SGPA					85/20=4.25

The CGPA shall also be calculated in similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

Declaration of Results:

Controller of Examinations (COE) of the University shall declare the results of given UG programme following the CGPA secured by students by the end of 6th Semester and 8th Semester.

PASS CLASSES

Range of CGPA	Result
9.0 above	First Class with distinction
6.0 above	First Class
5.0 Below 5.99	Second Class
4.0 - 4.99	Pass Class

PONDICHERRY UNIVERSITY

RAMANUJAN SCHOOL OF MATHEMATICAL SCIENCES

DEPARTMENT OF MATHEMATICS

NEP CURRICULUM & SYLLABI

FOR THE FOUR YEAR

B.Sc (Honours) with Research in MATHEMATICS OFFERED IN

AFFILIATED COLLEGES

TO BE IMPLEMENTED WITH EFFECT FROM THE ACADEMIC YEAR (2025-26 onwards)

Implementation of NEP in Affiliated Colleges NEP courses structure from the Academic Year 2025-26

Title of the Degree Programme (4 years) : Bachelor of Science in Mathematics (Honours with Research)

Titles of the Degree Programme (3 years): Bachelor of Science in Mathematics

Titles of Diplomas embodied (2 years) : UG Diploma in Mathematics

Titles of Certificates embodied (1 year) : UG Certificate in Mathematics

I. LIST OF MAJOR COURSES (Single Major)

SL. No	Nature of Course	Title of the Course(Single Major)	Credits	No. Hours of Teaching
1.	Major 1	Calculus	4	5
2.	Major 2	Matrices and Theory of Equations	4	5
3.	Major 3	Real Analysis - I	4	5
4.	Major 4	Optimizations Techniques	4	5
5.	Major 5	Real Analysis - II	4	5
6.	Major 6	Group Theory	4	5
7.	Major 7	Elements of Differential Equations	4	5
8.	Major 8	Computational Mathematics **(Practical)**	4	5
9.	Major 9	Ring Theory	4	5
10.	Major 10	Complex Analysis-I	4	5
11.	Major 11	Graph Theory	4	5
12.	Major 12	Introduction to Linear Algebra	4	5
13.	Major 13	Complex Analysis-II	4	5
14.	Major 14	Numerical Methods **(Practical)**	4	5
15	Major 15	Advanced Algebra	4	5
16	Major 16	Topology	4	5
17	Major 17	Advanced Real Analysis-I	4	5
18	Major 18	Advanced Real Analysis II	4	5
19	Major 19	Advanced Linear Algebra	4	5
20	Major 20	1. Differential Geometry	4	5
21	Major 21	2. Number Theory	4	5

22	Major 22	3. Discrete Dynamical Systems 4. Numerical Analysis for Ordinary Differential Equations 5. Lattice Theory 6. Integral Transforms and Their Applications 7. Integral Equations 8. Partial Differential Equations Note:- Students shall choose any of the above three courses from (1) to (8) if they do not choose the Research Project/ Dissertation.	4	5

- In semester V, MJD-8 (Computational Mathematics-Practical) will each include two additional hours of practical work.
- In semester VI, MJD-14 (Numerical Methods-Practical) will include two additional hours of practical work.
- Tutorial hours of one hour can be added to problem-oriented papers, depending on the available free hours.

II. LIST OF MINOR COURSES (ELECTIVES/ALLIED/SPECIALISATION)

a) With Minor Stream I (within Department and other disciplines)

SL. No	Title of the Minor Course(Single Major)	Credits	No. Hrs. of Teaching
Minor 1	Foundations of Data Science-I	4	5
Minor 2	Foundations of Data Science-II	4	5
Minor 3	Exploratory Data Analysis **(Practical)**	4	5
Minor 4	Data Wrangling with R **(Practical)**	4	5
Minor 5	Probability and Statistics	4	5
Minor 6	Interactive Data Visualization **(Practical)**	4	5
Minor 7	Calculus of Variations	4	5
Minor 8	Differential Equations and Special Functions	4	5

b) Minor Stream II (For all Disciplines)

- Stream II is designated for students from Arts, Commerce and Humanities.

Sl. No	Title of the Minor Course(Single Major)	Credits	No. Hours of Teaching
Minor 1	Computational Skills	4	5
Minor 2	Business Statistics	4	5
Minor 3	Numerical Analysis	4	5
Minor 4	Optimization Techniques-I	4	5
Minor 5	Optimization Techniques-II	4	5
Minor 6	Applied Statistics	4	5

c) Minor Stream III

- Minor Stream III is tailored for students pursuing a B.Sc. in Physics, Chemistry, or other science courses(Other than Mathematics).

SL. No	Title of the Minor Course(Single Major)	Credits	No. Hours of Teaching
Minor 1	Matrices and Trigonometry	4	5
Minor 2	Calculus	4	5
Minor 3	Vector Calculus	4	5
Minor 4	Introduction to Differential Equations	4	5
Minor 5	Fourier Series and Laplace Transforms	4	5
Minor 6	Numerical Analysis	4	5

III. MULTIDISCIPLINARY COURSES *

SL. No	Title	Credits	No. Hrs of Teaching
1.	Natural Science	3	4
2.	Physical Sciences	3	4
3.	Humanities / Social Sciences	3	4

*The common syllabus for MLDC courses is available on the University Website.

IV. ABILITY ENHANCEMENT COURSES *

a) English

SL. No	Title UG BOS may choose one course for the given UG Degree	Credits	No. Hrs. of Teaching
1.	English Language & Literature	2	4
2.	Functional English	2	4
3.	Spoken English	2	4

b) Indian Language

SL. No	Title	Credits	No. Hrs of Teaching
1.	Literature & Language	2	4
2.	Functional English	2	4
3.	Spoken English	2	4

* All UG courses will have 4 credits of English and 4 credits of Indian Language

V . SKILL ENHANCEMENT COURSES

SL. No	Title of the Skill/Vocational courses	Credits	No. Hrs. of Teaching
1	Python Programming **(Practical)**	3	4
2	R-Programming **(Practical)**	3	4
3	Latex **(Practical)**	3	4

BOS identifies courses suitable to the students from Skill India courses offered by MOOCs/SWAYAM courses/Any other approved list of 3rd party certificate courses sponsored by Industry, GOI at special apprenticeship courses designed by any polytechnic college, Govt. MSME Training centers, BOS may also consider any other skill programmes that other Departments of the given institution. These may include skill training in computer programming and other emerging technologies.

VI. VALUE-ADDED COMMON COURSES

SL. No	Title	Credits	No. Hrs. of Teaching
1.	Understanding India (1)	2	4
2.	Environmental Sciences/ Education (2)	2	4
3.	Health & Wellness / Yoga Education (3)	2	4
4.	Digital Technology Education (4)	2	4

A common course structure and syllabus shall be prepared by:
Dean, School of Social Sciences for subject 1
Dean, School of Life Sciences for subject 2
Director, Directorate of Sports & Physical Education for subject 3
Dean, School of Computer Science for subject 4

FIRST-YEAR

SEMESTER I

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-I	Major Course 1	4	5	Calculus
MID-I	Minor Course 1	4	5	Foundations of Data Science-I/ Electives offered by other departments
MLDC-I	Multi-Disciplinary Course 1	3	4	Natural Sciences
AEC-I	Ability Enhancement Course 1	2	4	English-1 or Indian Language - 1
SEC-I	Skill Enhancement Course 1	3	4	Python Programming **(Practical)**
VAC-I	Value-added Course 1	2	4	Understanding India (Theory/Field-based)
VAC-II	Value-added Course 2	2	4	Environmental Sciences/ Education
Total Courses/ Credits/ Hours	7 Courses	20	30	

SEMESTER II

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-II	Major Course 2	4	5	Matrices and Theory of Equations
MID-II	Minor Course 2	4	5	Foundations of Data Science-II/ Electives offered by other departments
MLDC-II	Multi-Disciplinary Course 2	3	4	Physical Sciences
AEC-II	Ability Enhancement Course 2	2	4	English-1 or Indian Language - 1
SEC-II	Skill Enhancement Course 2	3	4	R- Programming **(Practical)**
VAC-III	Value-added Course 3	2	4	Health, Wellness, Yoga Education, Sports & Fitness
VAC-IV	Value-added Course 4	2	4	Digital Technology Education
Total Courses/ Credits/	7 Courses	20	30	

SECOND YEAR

SEMESTER III

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-III	Major Course 3	4	5*	Real Analysis - I
MJD-IV	Major Course 4	4	5*	Optimizations Techniques
MID-III	Minor Course 3	4	4+2	Exploratory Data Analysis (**Practical)**/ Electives offered by other departments
MLDC-III	Multi-Disciplinary Course 3	3	4	Humanities/ Social Sciences
AEC-III	Ability Enhancement Course 3	2	4	English-2 or Indian Language - 2
SEC-III	Skill Enhancement Course 3	3	4	Latex **(Practical)**
Total Courses/ Credits/ Hours	6 Courses	20	28	

*Tutorial hours of one hour can be added to problem-oriented papers as per the available free hours

SEMESTER IV

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-V	Major Course 5	4	5	Real Analysis - II
MJD-VI	Major Course 6	4	5	Group Theory
MJD-VII	Major Course 7	4	5	Elements of Differential Equations
MID-IV	Minor Course 4	4	5	Data Wrangling with R (**Practical)**/ Electives offered by other departments
AEC-IV	Ability Enhancement Course 4	2	4	English-2 or Indian Language - 2
VAC-V	Value Added Course	2	6	Community Engagement and Service
Total Courses/ Credits/ Hours	6 Courses	20	30	

THIRD YEAR

SEMESTER V

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-VIII	Major Course 8	4	4+2	Computational Mathematics (**Practical)**
MJD-IX	Major Course 9	4	5*	Ring Theory
MJD-X	Major Course 10	4	5*	Complex Analysis- I
MID-V	Minor Course 5	4	5*	Probability and Statistics/ Electives offered by other departments
SEC	Skill Enhancement Course	4	6	Summer Internship for 45 days
Total Courses/ Credits/ Hours	5 Courses	20	27	

*Tutorial hours of one hour can be added to problem-oriented papers as per the available free hours

SEMESTER VI

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-XI	Major Course 11	4	5*	Graph Theory
MJD-XII	Major Course 12	4	5*	Introduction to Linear Algebra
MJD-XIII	Major Course 13	4	5*	Complex Analysis- II
MJD-XIV	Major Course 14	4	4+2	Numerical Methods (**Practical)**
MID-VI	Minor Course 6	4	4+2	Interactive Data Visualization (**Practical**)/ Electives offered by other departments
Total Courses/ Credits/ Hours	5 Courses	20	27	

*Tutorial hours of one hour can be added to problem-oriented papers as per the available free hour

FOURTH YEAR

SEMESTER VII

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-XV	Major Course 15	4	5*	Advanced Algebra
MJD-XVI	Major Course 16	4	5*	Topology
MJD-XVII	Major Course 17	4	5*	Advanced Real Analysis-I
MID-VII	Minor Course 7	4	5*	Calculus of Variations
MID-VIII	Minor Course 8	4	5*	Differential equations and special functions
Total Courses/ Credits/ Hours	5 Courses	20	25	

*Tutorial hours of one hour can be added to problem-oriented papers as per the available free hours

SEMESTER VIII

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-XVIII	Major Course 18	4	5*	Advanced Real Analysis -II
MJD-XIX	Major Course 19	4	5*	Advanced Linear Algebra
		12	15	Research Project / Dissertation
MJD-XX	Major Course 20	4	5*	1. Differential Geometry 2. Number Theory 3. Discrete Dynamical Systems 4. Numerical Analysis for Ordinary Differential Equations 5. Lattice Theory 6. Integral Transforms and Their Applications 7. Integral Equations 8. Partial Differential Equations <u>Note:-</u> Students shall choose any of the above three courses from (1) to (8) if they do not choose the Research Project/ Dissertation.
MJD-XXI	Major Course 21	4	5*	
MJD- XXII	Major Course 22	4	5*	
Total Courses/ Credits/ Hours	5 Courses	20	25	

*Tutorial hours of one hour can be added to problem-oriented papers as per the available free hours

*Free hours apart from Major courses can be utilized for research projects and Dissertations.

LIST OF MINOR COURSES (ELECTIVES/ALLIED/SPECIALISATION)

These courses are designed for students from Physics, Chemistry, Biology, Computer Science, B.Com (General), B.Com (CS), etc. These courses will be floated depending on the number of students registering and the availability of the faculty. The number of students may be restricted depending on the available classroom facility and first-cum-first serve basis.

a) With Minor Stream I (within the Department and other disciplines**)**

Course Code	Type of Course	Credits	Hours	Title of the Course
MID-I	Minor Course 1	4	5	Foundations of Data Science-I
MID-II	Minor Course 2	4	5	Foundations of Data Science II
MID-III	Minor Course 3	4	5	Exploratory Data Analysis **(Practical)**
MID-IV	Minor Course 4	4	5	Data Wrangling with R **(Practical)**
MID-V	Minor Course 5	4	5	Probability and Statistics
MID-VI	Minor Course 6	4	5	Interactive Data Visualization **(Practical)**
MID-VII	Minor Course 7	4	5	Calculus of Variations
MID-VIII	Minor Course 8	4	5	Differential Equations and Special Functions

b) With Minor Stream II (Stream II is designated for students from Arts, commerce and Humanities)

Course Code	Type of Course	Credits	Hours	Title of the Course
MID-I	Minor Course 1	4	5	Computational Skills
MID-II	Minor Course 2	4	5	Business Statistics
MID-III	Minor Course 3	4	5	Numerical Analysis
MID-IV	Minor Course 4	4	5	Optimization Techniques-I
MID-V	Minor Course 5	4	5	Optimization Techniques-II
MID-VI	Minor Course 6	4	5	Applied Statistics

c) **With Minor Stream III**

- Minor Stream III is tailored for students pursuing B.Sc. in Physics, Chemistry, and other science courses(Other than Mathematics).

Course Code	Type of Course	Credits	Hours	Title of the Course
MID-I	Minor Course 1	4	5	Matrices and Trigonometry
MID-II	Minor Course 2	4	5	Calculus
MID-III	Minor Course 3	4	5	Vector Calculus
MID-IV	Minor Course 4	4	5	Introduction to Differential Equations
MID-V	Minor Course 5	4	5	Fourier Series and Laplace Transforms
MID-VI	Minor Course 6	4	5	Numerical Analysis

Skill Enhancement Courses

Course Code	Offered in the Semester	NEP Classification	Credits	Hours	Title of the Course
SEC-I	I	Skill Enhancement Course 1	3	4	Python Programming **(Practical)**
SEC-II	II	Skill Enhancement Course 2	3	4	R-Programming **(Practical)**
SEC-III	III	Skill Enhancement Course 3	3	5	Latex **(Practical)**

Multi-Disciplinary Course for all Arts, Commerce, and Science students (Except Mathematics)

Course Code	Offered in the Semester	NEP Classification	Credits	Hours	Title of the Course
MLDC-II	II	Multi Disciplinary Course 2	3	4	Basic Mathematics

LIST OF MAJOR COURSES (SINGLE MAJOR)

Title of the course	CALCULUS	Nature of the Course	Major-1	Subject Code	MTDSMA01
Credits	4	Semester	1	Type of course	Theory
No. of Hours of Teaching	75				
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic problem solving skills				

Course Outcomes

CO1	Apply standard results, trigonometric transformations, and Leibnitz's formula to find higher-order derivatives and solve equations involving derivatives.
CO2	Compute total differential coefficients, apply Euler's theorem for homogeneous functions, and analyze maxima and minima of functions of two variables using Lagrange's method of undetermined multipliers.
CO3	Understand and calculate the radius and center of curvature of a circle, derive the Cartesian formula for the radius of curvature, and determine the envelope of a family of curves.
CO4	Solve problems involving the integration of rational and irrational algebraic functions and demonstrate a clear understanding of the properties of definite integrals.
CO5	Use integration by parts, reduction formulas, and Bernoulli's formula to evaluate integrals, and compute double and triple integrals in Cartesian coordinates.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	n^{th} derivative – Standard results – Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula	**15**
2	Total differential coefficients – Euler's theorem – Partial derivatives of a function of two functions - Maxima and Minima of two variables – Lagrange's method of undetermined multipliers	**15**
3	Circle, radius and centre of curvature – Cartesian formula for radius of curvature – envelope	**15**
4	Integration of rational algebraic functions – Integration of irrational algebraic functions - Properties of definite integrals	**15**
5	Integration by parts – reduction formula, Bernoulli's formula - Evaluation of double integral (Cartesian form only) – Triple integral (Cartesian form only)	**15**

Prescribed Text

1	Calculus Volume- I, T. K. Manickavachagom Pillai, Printers and Publishers (May1992 Edition). Unit 1: Chapter 3 - 1.1, 1.2, 1.3, 1.4,1.5, 1.6, 2.1, Unit 2: Chapter 8- 1.3, 1.4, 1.5, 1.6, 1.7, 4, 4.1, 5 Unit 3: Chapter 10 - 1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5
2	Calculus Volume II , S. Narayanan and T.K. Manickavasagam Pillai (2008) Unit 4 : Chapter 1 : 7.3, 7.4, 7.5, 8, 11, Unit 5 : Chapter 1: 12,13,14, 15.1, and Chapter 5: 2, 4,

Books for Reference

1	Integral Calculus, N. P. Bali, Laxmi Publications, Delhi, (1991)
2	Calculus (2e), Lipman Bers and Frank Karal, Holt McDougal, 1976.
3	Thomas' Calculus 12th Edition, George B.Thomas, Maurice D.Weir and Joel Hass, Pearson Edu, 2015.

Title of the course	MATRICES AND THEORY OF EQUATIONS	Nature of the Course	Major 2	Subject Code	MTDSMA02
Credits	4	Semester	2	Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Students should have basic knowledge of algebra, including polynomial operations and equations. Familiarity with matrices and solving linear equations is essential.				

Course Outcomes

CO1	Understand the basic concepts of matrices, including inner product, rank, and solving simultaneous equations.
CO2	Explore eigenvalues, eigenvectors, and similar matrices, and apply the Cayley-Hamilton theorem to solve problems.
CO3	Analyze the theory of equations, including the remainder theorem, relations between roots and coefficients, symmetric functions, and Newton's theorem.
CO4	Apply Descartes' rule of signs, Rolle's theorem, and Strum's theorem, and solve numerical equations involving multiple roots.
CO5	Solve cubic and biquadratic equations using methods like Cardano's method, the trigonometric method, and Horner's method.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Matrices–Introduction – Inner product - Solution of simultaneous equations – Rank of a Matrix	15
2	System of non-homogeneous linear equations - Eigen values and Eigen vectors – Similar Matrices – Cayley-Hamilton Theorem	15
3	Theory of equations – Introduction – Remainder theorem – Relations between the roots and coefficients of equations – symmetric function of the roots – sum of the powers of the roots of an equation – Newton's theorem on the sum of the powers of the roots -	15
4	Descartes' Rule of signs – Rolles' theorem – Multiple roots – Strums' theorem – Solutions of Numerical equations	15
5	Newton's method of divisor – Horner's Method – General solution of the cubic equations – Cardon's method – Trigonometrical method – Solution of biquadratic equations	15

Prescribed Text

1	T K Manicavachagom Pillay, T Natarajan , K S Ganapathy, Algebra Volume II, S. Viswanathan(Printers & Publishers) Pvt Ltd. (2011) Unit I: (Section 1,2,3,4,5,6,7,8,9,10,11), Unit II: (Section 16)
2	T K Manicavachagom Pillay, T Natarajan , K S Ganapathy, Algebra Volume I, S. Viswanathan(Printers & Publishers) PVT LTD. (2006) Unit III: (Sections 1-14), Unit IV: (section 24-28), Unit V: (29,30,34,35)

Books for Reference

1	P.R.Vittal, V.Malini, Algebra, Analytical Geometry and Trigonometry, Margham Publications
2	Erwin Kreyszig, Advanced Engineering Mathematics, 9e, Wiley Publication.

Title of the course	REAL ANALYSIS-I	Nature of the Course	Major-3	Subject Code	MTDSMA03
Credits	4	Semester	3	Type of course	Theory
No. of Hours of Teaching	75				
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Students should have basic knowledge of set theory, functions, and real numbers. Familiarity with limits, continuity, and elementary algebra is essential.				

Course Outcomes

CO1	Understand the fundamental concepts of sets, set operations, functions, equivalence relations, countability, and properties of real numbers such as the least upper bound and greatest lower bound.
CO2	Analyze sequences and subsequences, including their limits, convergence, boundedness, monotonicity, and operations on convergent sequences, along with concepts of limit superior, limit inferior, and Cauchy sequences.
CO3	Explore the convergence and divergence of series, including series with non-negative terms, alternating series, conditional and absolute convergence
CO4	Examine the limits of functions on the real line and metric spaces, and develop a deep understanding of limit properties in metric spaces through examples.
CO5	Investigate the concept of continuity of functions at a point on the real line and in metric spaces, study open and closed sets.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Sets and elements - Operations on sets - Functions - Real valued functions Equivalence— Countability- Real numbers upper bound- Greatest lower bound	**15**
2	Definition of sequence and subsequence - Limit of a sequence - Convergent sequence - Bounded sequence Monotone sequence - Operation on convergent sequence-Limit superior and limit inferior- Cauchy sequence	**15**
3	Convergence and divergence- Series with non-negative terms - Alternating series-Conditional convergence and absolute convergence	**15**
4	Limit of a function on the real line - Metric spaces (Examples 4 and 5 under 4.2c to be omitted)-Limits in metric spaces.	**15**
5	Functions continuous at a point on the real line -Functions continuous on a metric space -Open sets, Closed Sets.	**15**

Prescribed Text

1	Methods of Real Analysis, Treatment as in Richard R. Goldberg(1970) Unit 1 :Chapter 1(Sections 1.1-1.7), Unit 2: Chapter 2(Sections 2.1, 2.2, 2.3, 2.5, 2.6, 2.7, 2.9), Unit 3: Chapter 3(Sections 3.1,3.2,.3.3. 3.4). Unit 4 : Chapter 4(sections 4.1, 4.2, 4.3), and Unit 5 :Chapter 5(sections 5.1, 5.3,5.4, 5.5).

Books for Reference

1	A First Course in Mathematical Analysis- D Somasundaram & B Choudhyri-Narosa Publishing house New Delhi
2	Introduction to Calculus and Analysis, Vol.I, Richard Courant and Fritz John, Springer 1999.
3	Introduction to Real Analysis, 4th Edition, Robert G.Bartle and Donald R.Sherbert,Wiley-2014.

Title of the course	OPTIMIZATION TECHNIQUES	Nature of the Course	Major 4	Subject Code	MTDSMA04
Credits	4	Semester	3	Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem-solving skills				

Course Outcomes	
CO1	Understand and comprehend the basics of Linear Programming Problems (LPP).
CO2	Learn LPP-solving methods and explore duality in LPP.
CO3	Solve assignment problem and its variants
CO4	Find feasible and optimal solutions for transportation problems
CO5	Perform critical path analysis and review of a project.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Operation Research – Definition – Characteristics – Techniques – Applications. LPP – Introduction – Applications and components of LPP – Steps in solving LPP	15
2	Mathematical formulation – Graphical method – Simplex method – Artificial variables – Big-M method - Two-phase method – Degeneracy and unbound solutions – Duality in LPP – Formulation – Relationship between primal and dual problems.	15
3	Mathematical formulations - Hungarian Method – Variants of the Assignment problem	15
4	Mathematical formulation – Finding basic feasible solutions – NWCR, LCM, and VAM – Optimal solution – MODI method	15
5	Introduction – Basic components – Logical sequencing – Rules of network construction – Concurrent Activities – Critical Path Analysis - Activity Time and Floats – Project Evaluation and Review Technique (PERT) – Three Time Estimates – Critical Path Analysis of PERT network – Probability of completion of Project	15

Prescribed Text	
1	Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 20th Edition, 2023.
Books for Reference	
2	Taha H.A., Operations Research: An Introduction, Pearson Education, 10th Edition, 2019.

Title of the course	REAL ANALYSIS-II	Nature of the Course	Major-5	Subject Code	MTDSMA05

Credits	4	Semester	2	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Students should have a foundational understanding of metric spaces, limits, continuity, and differentiation. Familiarity with basic integration techniques and algebraic functions is also essential.

Course Outcomes

CO1	Understand open, connected, bounded, and totally bounded sets, and explore complete metric spaces.
CO2	Analyze compact metric spaces and study continuous functions, including the continuity of inverse functions.
CO3	Define sets of measure zero, comprehend the Riemann integral, and understand its properties.
CO4	Apply concepts of derivatives, Rolle's theorem, the Law of the Mean, and the Fundamental Theorem of Calculus.
CO5	Explore hyperbolic functions, exponential and logarithmic functions, trigonometric functions, and Taylor's theorem.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	More about open sets - Connected sets. Bounded sets and totally bounded sets - Complete metric spaces.	15
2	Compact metric spaces, Continuous functions on compact metric Spaces - Continuity of the inverse function.	15
3	Sets of measure zero - Definition of the Riemann- Properties of the Riemann integral	15
4	Derivatives - Rolle's theorem - The Law of the Mean - Fundamental theorem of Calculus.	15
5	Hyperbolic function - The exponential function - The logarithmic function - Definition of x^a - The trigonometric function - Taylor Theorem.	15

Prescribed Text

1	Methods of Real Analysis, Treatment as in Richard R. Goldberg, (1970). Unit 1: 6.1 to 6.4, Unit 2: 6.5 to 6.7, Unit 3: 7.1, 7.2, and 7.4, Unit 4: 7.5 to 7.8, Unit 5: 8.1 to 8.5

Reference Books

1	First Course in Mathematical Analysis by Dr.Somasundaram & B Choudhyri- Narosa Publishing house New Dehli
2	Real Analysis- byShanti Narayanan

Title of the course	GROUP THEORY	Nature of the Course	Major 6	Subject Code	MTDSMA06

Credits	4	Semester	4	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic mathematical and problem-solving skills

Course Outcomes

CO1	Understand the definition, examples, and elementary properties of groups, and analyze subgroups using subgroup tests.
CO2	Explore cyclic groups, their properties, and the classification of their subgroups, along with the structure and properties of permutation groups using cycle notation.
CO3	Investigate group isomorphisms, Cayley's theorem, automorphisms, properties of cosets, and Lagrange's theorem with its consequences.
CO4	Analyze external and internal direct products, study the group of units modulo n, and understand normal subgroups, factor groups, and their applications.
CO5	Examine group homomorphisms, their properties, and the first isomorphism theorem, and explore the fundamental theorem of finite abelian groups and their isomorphism classes.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Introduction to Groups - Definition and Examples of Groups – Elementary Properties of Groups –Subgroups - Subgroup Tests - Examples of Subgroups.	**15**
2	Cyclic Groups - Properties of Cyclic Groups - Classification of Subgroups of Cyclic Groups – Permutation Groups - Cycle Notation - Properties of Permutations.	**15**
3	Isomorphisms - Cayley's Theorem - Properties of Isomorphisms – Automorphisms - Properties of Cosets - Lagrange's Theorem and Consequences.	**15**
4	External Direct Products – Properties of External Direct Products - The Group of Units Modulo n as an External Direct Product - Normal Subgroups - Factor Groups - Applications of Factor	**15**
5	Group Homomorphisms - Properties of Homomorphisms - The First Isomorphism Theorem – Fundamental Theorem of Finite Abelian Groups (without proof) - The Isomorphism Classes of Abelian Groups.	**15**

Prescribed Text

1	Joseph A. Gallian, Contemporary Abstract Algebra, 8th Edition, Cengage Learning India Private Limited (Chapter 2 to Chapter 12)

Books for Reference

1	M. Artin: Algebra, Prentice-Hall of India, 1991
2	I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975

Title of the course	ELEMENTS OF DIFFERENTIAL EQUATIONS	Nature of the Course	Major 7	Subject Code	MTDSMA07

Credits	4	Semester	4	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic mathematical and problem-solving skills

Course Outcomes

CO1	To solve a system of first-order ODEs
CO2	To analyze the stability of a Dynamical System using Differential Equations and their solutions
CO3	To Solve First Order Partial Differential Equations
CO4	To understand ordinary and first-order partial differential equations and their applications
CO5	To enable students to understand solving the first and second-order ODES and first-order PDEs.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Exact differential equations- Integrating factors – Linear differential equations- Bernoulli equation –Modeling: Electric circuits – Orthogonal trajectories of curves.	15
2	Homogeneous linear equations of second order – Second order homogeneous equations with constant coefficients – Case of complex roots- Complex exponential function – Differential operators Modeling:- Free oscillations – Euler-Cauchy equation – Existence and uniqueness theory – Wronskian.	15
3	Non-homogeneous equations – Solution by undetermined coefficients – Solution by variation of parameters – Modeling of electric circuits – Higher order linear differential equations – Higher order homogeneous equations with constant coefficients.	15
4	Introduction: vectors, matrices, eigenvalues – Introductory examples – Basic concepts and theory –Homogeneous systems with constant coefficients, phase plane, critical points – Criteria for critical points, Stability.	15
5	Non-linear first order PDEs : Compatible systems- Solutions of Quasi linear equations Charpit's method- Special Types of Charpits Method, - Integral surfaces through a given curve-The Cauchy problem for Quasi Linear case and nonlinear first order PDEs	15

Prescribed Text

1	Erwin Kreyszig, Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 1999. Unit-I: Sections 1.5-1.8; Unit-II: Sections 2.1-2.7; Unit-III: Sections 2.8-2.10, 2.12, 2.13, 2.14; Unit-IV: Sections 3.0-3.4;
2	K. Shankara Rao, Introduction to Partial Differential Equations, PHI Publications, 3rd Edition. 2011. Unit V – Chapter 0

Books for Reference

1	George F. Simmons, Differential Equations, Tata McGraw-Hill, New Delhi, 1972
2	Boyce and Di Prima, Differential Equations and Boundary Value Problems, Wiley,10th edition 2012.
3	Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall of India Private Ltd, 1991.

Title of the course	COMPUTATIONAL MATHEMATICS (Practical)	Nature of the Course	Major 8	Subject Code	MTDSMA08
Credits	4	Semester	5	Type of course	Practical
No. of Hours of Teaching	75				
Internal Assessment Marks (IA)	50	End Semester Examination (ESE)	50	Duration of ESE	3 hrs
Course Prerequisites, if any	1. Basic mathematical and problem-solving skills 2. Python Programming skills				

Course Outcomes

CO1	Solve systems of linear equations using methods of Gaussian elimination
CO2	Demonstrate understanding of the concepts of vector space, linear independence, and basis.
CO3	Determine eigenvalues and eigenvectors and solve eigenvalue problems
CO4	Demonstrate understanding of the use of truth tables and laws of identity, distributive, commutative, and domination
CO5	Simplify and prove Boolean expressions, compute the sum of products and product of sum expansions.

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	System of Linear Equation: Matrices, Determinants, Cramer's Rule, Echelon form, Row reduction, Gaussian elimination method	9
2	Vector Spaces: Introduction to vector spaces, Some properties of vector spaces, Linear combination, Linear independence, Linear dependence, Basis and Dimension of a vector space, Row space, Column space.	9
3	Eigen values and Eigen vectors: Eigen values and Eigen vectors, The characteristic equation, Diagonalization.	9
4	Boolean function: Relations, Types of Relations, Equivalence relations, Digraphs of relations, Matrix representation and Composition of Relations, Transitive closure and Warshall's Algorithm, Poset, Hasse diagram, Boolean Functions: Introduction, Boolean variable, Boolean Function of degree n, Boolean identities.	9
5	Boolean algebra: Definition of Boolean Algebra, Representation of Boolean Functions: Minterm, Maxterm Disjunctive normal form-Conjunctive normal Form.	9
	Practical Component - Internal Assessment marks (IA)-50	
1	Problem-Solving on Unit 1: System of Linear Equation using Python	30
2	Problem-Solving on Unit 2: Vector Spaces using Python	
3	Problem-Solving on Unit 3: Eigenvalues and Eigenvectors using Python	
4	Problem-Solving on Unit 4: Boolean function using Python	
5	Problem-Solving on Unit 4: Boolean Algebra using Python	

Prescribed Text

1	Howard Anton, Chris Rorres, Elementary Linear Algebra, Application Version, Ninth Edition, Wiley
2	Discrete Mathematical Structures, by Kolman, Busby, Ross, Rehman, Prentice Hall

Books for Reference

1	K. Hoffman and R. Kunze, Linear Algebra, 2nd edition(2014), Prentice Hall of India, NewDelhi
2	Steven J. Leon, Linear Algebra with Applications, 4th edition(1994), Prentice Hall of India.New Delhi.
3	John Bird, Bird's Higher Engineering Mathematics, (9e), Routledge, Taylor & Francis Group, 2021

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	RING THEORY	Nature of the Course	Major 9	Subject Code	MTDSMA09

Credits	4	Semester	5	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	A basic understanding of set theory, functions, and foundational algebra, including binary operations, properties of integers, and introductory group theory.

Course Outcomes

CO1	Understand the definition, motivation, examples, and properties of rings, subrings, integral domains, fields, and the characteristics of a ring.
CO2	Analyze the structure and properties of ideals, factor rings, prime ideals, maximal ideals, and ring homomorphisms, including the construction of the field of quotients.
CO3	Explore polynomial rings, apply the division algorithm, and study principal ideal domains, factorization of polynomials, reducibility tests, and irreducibility tests.
CO4	Investigate unique factorization in Z[x], divisibility in integral domains, and the concepts of irreducibles and primes, with applications of unique factorization.
CO5	Examine advanced algebraic structures like unique factorization domains and Euclidean domains, and understand their historical significance through discussions on Fermat's Last Theorem.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Introduction to Rings - Motivation and Definition of Rings – Examples of Rings – Properties of Rings – Subrings - Definition and Examples of Integral Domains – Fields - Characteristics of a Ring	15
2	Ideals - Factor Rings - Prime Ideals and Maximal Ideals - Definition and Examples of Ring Homomorphisms - Properties of Ring Homomorphisms - The Field of Quotients.	15
3	Polynomial Rings - The Division Algorithm and Consequences - Principal ideal domain - Factorization of Polynomials - Reducibility Tests - Irreducibility Tests	15
4	Unique Factorization in Z[x] - Weird Dice: An Application of Unique Factorization - Divisibility in Integral Domains – Irreducibles and Primes	15
5	Historical Discussion of Fermat's Last Theorem - Unique Factorization Domains – Euclidean Domains.	15

Prescribed Text

1	Joseph A. Gallian, Contemporary Abstract Algebra, 8th Edition, Cengage Learning India Private Limited. Chapter 12 to Chapter 18

Books for Reference

1	M. Artin: Algebra, Prentice-Hall of India, 1991
2	I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
3	David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), John Wiley and sons, 2004

Title of the course	COMPLEX ANALYSIS-I	Nature of the Course	Major 10	Subject Code	MTDSMA10

Credits	4	Semester	5	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Students should have prior knowledge of basic algebra, trigonometry, and calculus. Familiarity with functions, derivatives, and properties of real numbers is essential to understand complex numbers and their applications.

Course Outcomes

CO1	Demonstrate understanding of complex numbers, including their definitions, algebraic properties, Cartesian and polar representations, triangular inequality, powers, roots, and regions in the complex plane.
CO2	Analyze the concept of analytic functions, limits, continuity, and differentiation of complex functions, applying Cauchy-Riemann equations and sufficient conditions for differentiability.
CO3	Extend the application of Cauchy-Riemann equations in polar form to identify analytic and harmonic functions and their significance in complex analysis.
CO4	Explore elementary functions, such as exponential, trigonometric, hyperbolic, and logarithmic functions, including their branches, properties, inverse functions, and complex exponents.
CO5	Apply transformations in the complex plane, including mappings by elementary functions, linear fractional transformations, and successive transformations.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Complex numbers-Definitions-Algebraic properties–Cartesian coordinates - Triangular inequality – Polar Form - Powers and roots - Region in the complex plane.	15
2	Analytic functions - Functions of a complex variable -Mapping -Limit - Theorems on limits – Continuity - Derivatives -Differentiation formula- Cauchy Riemann equations–Sufficient conditions.	15
3	Cauchy Riemann equations in polar form - Analytic functions – Harmonic functions.	15
4	Elementary functions - Exponential function – Trigonometric functions and their--Hyperbolic functions–Logarithmic function – Branches - properties of logarithms - Complex exponents –Inverse trigonometric & hyperbolic functions.	15
5	Mapping by elementary functions - The linear function 1/z – Linear fractional transformation-The function $w=e^z$, W=sin z, W=Cos z, $z^{1/2}$- Successive transformation W= z+1/z	15

Prescribed Text

1	Complex Variables and Applications, James Ward Brown and Ruel V Churchill ,Mc Graw-Hill, International Edition (2009). UNIT I-chapter 1, UNIT II-chapter 2, UNIT III-chapter 2, UNIT I -chapter 3, UNIT V-chapter 4.

Books for Reference

1	Functions of a Complex variable by B. S. Tyagi – KedarNath Ram Nath Publishers(P)Ltd
2	Complex Analysis by P. Duraipandian and Kayalal Pachaiappa –S.Chand & Co
3	S.Ponnusamy, Foundations of Complex analysis,(2ndEdition), Narosa,2011. V. Karunakaran, Complex Analysis, (2^{nd}Edition), Narosa2005

Title of the course	GRAPH THEORY	Nature of the Course	Major 11	Subject Code	MTDSMA11

Credits	4	Semester	6	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic understanding of set theory, relations, functions, and combinatorics.

Course Outcomes

CO1	Demonstrate a strong understanding of fundamental concepts in graph theory, including subgraphs, isomorphism, degrees of vertices, paths, connectedness, and automorphisms, with applications to simple graphs and trees.
CO2	Analyze and apply advanced techniques to count spanning trees using Cayley's formula, understand vertex cuts and edge cuts, and determine the connectivity and edge-connectivity of graphs.
CO3	Solve problems involving vertex-independent sets, vertex coverings, edge-independent sets, matchings, and factors, including bipartite graph matchings, Hall's theorem, and Tutte's 1-factor theorem.
CO4	Explore and determine the necessary and sufficient conditions for Eulerian and Hamiltonian graphs, apply Dirac's theorem, and use graph closure to study the existence of Hamiltonian cycles.
CO5	Evaluate vertex coloring, chromatic numbers, critical graphs, and edge coloring of graphs, applying Brooks' theorem, Vizing's theorem, and Euler's formula to analyze planar and nonplanar graphs.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Graphs – Subgraphs – Isomorphism of graphs – Degrees of Vertices – Paths and Connectedness – Automorphism of a Simple Graph – Trees – Centers and Centroid.	**15**
2	Counting the Number of Spanning Trees – Cayley's Formula– Vertex Cuts and Edge Cuts – Connectivity and Edge-connectivity.	**15**
3	Vertex Independent sets and Vertex Coverings – Edge-Independent Sets – Matchings and Factors –M Augmenting Paths – Matchings in Bipartite Graphs – Halls Theorem on Bipartite graphs – Tutte's 1-Factor Theorem (without proof).	**15**
4	Eulerian graphs – Necessary and sufficient condition for Eulerian graphs – Hamiltonian graphs – Dirac theorem –Closure of a graph.	**15**
5	Vertex Coloring – Chromatic Number –Critical Graphs – Brooks' Theorem – Edge Colorings of Graphs – Vizing's Theorem (without proof) – Planar and Nonplanar Graphs – Euler's Formula and its Consequences.	**15**

Prescribed Text

1	R. Balakrishnan and K. Ranganathan, A Textbook of Graph Theory (Universitext), Second Edition, Springer New York 2012. Chapter 1: 1.1-1.6, Chapter 3: 3.1-3.3, Chapter 4: 4.1-4.5, Chapter 5: 5.1-5.5, Chapter 6: 6.1-6.3, Chapter 7: 7.1,7.2,7.3.1, 7.6.2, Chapter 8: 8.1-8.3.

Books for Reference

1	Bondy, J.A and Murthy, U.S.R, Graph Theory with Applications, Macmillan Press Ltd, New Delhi – (1976).
2	Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi-2011.

Title of the course	INTRODUCTION TO LINEAR ALGEBRA	Nature of the Course	Major 12	Subject Code	MTDSMA12

Credits	4	Semester	6	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of matrices, determinants, set theory, and solving systems of linear equations.

Course Outcomes

CO1	Understand the fundamental concepts of abstract algebra, vector spaces, subspaces, linear dependence/independence, and basis and dimension to analyze and solve problems in linear algebra.
CO2	Explore linear transformations, null and range spaces, matrix representation, invertibility, isomorphisms, and change of coordinate matrices to comprehend advanced linear algebraic structures.
CO3	Perform elementary matrix operations, calculate matrix inverses, determine the rank of matrices, and solve systems of linear equations using both theoretical and computational techniques.
CO4	Evaluate determinants, their properties, eigenvalues, eigenvectors, diagonalizability, and invariant spaces, and apply the Cayley-Hamilton theorem to analyze matrices.
CO5	Apply inner product spaces, norms, and the Gram-Schmidt orthogonalization process to work with orthogonal complements and solve geometric problems in vector spaces.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Abstract Algebra Concepts – Groups- Subgroups- Fields- examples Vector space- Subspace-linear combinations and systems of linear equations- Linear dependence and linear independence- Basis and dimension.	15
2	Linear Transformations- Null spaces- Range spaces- Dimension theorem- Matrix representation of linear transformation- composition of linear transformations and Matrix multiplication- Invert ability and Isomorphism- The change of coordinate matrix.	15
3	Elementary matrix Operations and elementary matrices- The rank of a matrix and matrix inverses- systems of linear equations- Theory and computation	15
4	Determinants of order 2 and order n- properties of determinants- Important facts about determinants- Eigen values and Eigen vectors- Diagonalizability- Invariant spaces and Cayley- Hamilton theorem.	15
5	Inner products and norms- The Gram-Schmidt orthogonalization process and orthogonal complements.	15

Prescribed Text

1	Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Linear Algebra, 4th Edition, Printice Hall of India Pvt. Ltd., 2006, Unit I: 1.2 to 1.6, Unit II: 2.1 to 2.5, Unit III: 3.1 to 3.4, Unit IV: 4.1 to 4.4 and 5.1 to 5.2, 5.4 Unit V: 6.1, 6.2

Books for Reference

1	S. Kumaresan, Linear Algebra Geometric Approach, Prentice Hall of India Pvt. Ltd., 2000.
2	I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley & Sons, 2003.

Title of the course	COMPLEX ANALYSIS-II	Nature of the Course	Major 13	Subject Code	MTDSMA13

Credits	4	Semester	6	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of complex numbers, and calculus. Familiarity with elementary algebraic concepts and fundamental theorems in analysis.

Course Outcomes

CO1	Understand and evaluate contour integrals, apply Cauchy-Goursat's theorem in simply and multiply connected domains, and demonstrate its proof using preliminary lemmas.
CO2	Utilize the Cauchy integral formula and its applications to derive derivatives of analytic functions, and explore the implications of Morera's theorem, Liouville's theorem, and the fundamental theorem of algebra.
CO3	Analyze the convergence of sequences and series, develop Taylor and Laurent series expansions, and apply them to solve problems involving analytic functions.
CO4	Classify and analyze singularities, compute residues, and apply the residue theorem to evaluate integrals, understand the principal part of functions, and identify zeros and poles of order m.
CO5	Evaluate integrals of specific types, such as improper integrals involving rational functions, trigonometric functions, and periodic functions.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Contour integrals- Examples - The Cauchy Goursat's theorem -A preliminary lemma- Proof of Cauchy Goursat's theorem -Simply and multiple connected domains.	15
2	The Cauchy integral formula -Derivatives of analytic functions- Morera's theorem - Maximum moduli of functions- Liouville's theorem-The fundamental theorem of algebra.	15
3	Convergence of sequences and series - Taylor series -Observations and examples–Laurent Series (statement only).	15
4	Singularities-Definitions and examples residue theorem - The principal part of a function- Residues and poles – zeros and poles of order m.	15
5	$Type\ 1$: $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)} dx$, $Type\ 2$: $\int_{-\infty}^{\infty} \frac{p(x)}{q(x)} \sin ax\, dx\ (or) \int_{-\infty}^{\infty} \frac{p(x)}{q(x)} \cos ax\, dx$ $Type\ 3$: $\int_0^{2\pi} F(\sin\theta, \cos\theta)\, d\theta$, Where p(x) and q(x) are real polynomials with no factor in common and q(x) has no real zeros.	15

Prescribed Text

1	Complex Variables and Applications, James Ward Brown and Ruel V Churchill, Mc Graw Hill, International Edition(1990) Unit I : Chapter 4:Section 34-38, Unit II: Chapter 4 : Section 39-43, Unit III: Chapter 5: Section 44-48, Unit IV: Chapter 6: Section 53-57, Unit V: Chapter 6: Section 58-60

Books for Reference

1	Functions of a Complex variable by B. S. Tyagi – KedarNath RamNath Publishers(P)Ltd.
2	Complex Analysis by P. Duraipandian and Kayalal Pachaiappa –S.Chand & Co.

Title of the course	NUMERICAL METHODS (Practical)	Nature of the Course	Major 14	Subject Code	MTDSMA14

Credits	4	Semester	6	Type of course	Practical	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	50	End Semester Examination (ESE)	50	Duration of ESE	3 hrs

Course Pre requisites if any	Basic understanding of calculus, including derivatives and integrals. Familiarity with algebra, linear equations, and differential equations. Introductory knowledge of finite differences and basic computational techniques. Knowledge in using Python programming Language is also essential for the practical component

Course Outcomes

CO1	Apply numerical methods such as bisection, successive approximation, Regula-Falsi, and Newton-Raphson methods to solve algebraic and transcendental equations effectively.
CO2	Solve systems of simultaneous linear algebraic equations using techniques like Gauss elimination, Gauss-Jordan elimination, and Gauss-Seidel iteration methods.
CO3	Utilize finite difference operators for interpolation and compute numerical differentiation and integration using methods such as Newton-Gregory, Lagrange's interpolation, Trapezoidal rule, and Simpson's 1/3rd rule.
CO4	Solve ordinary differential equations of first and second order using numerical methods like Taylor series, Picard's method, and Euler's methods, including their improved and modified forms.
CO5	Analyze and implement advanced numerical methods like Runge-Kutta methods (second and fourth order) and Milne's predictor-corrector method for solving ordinary differential equations.

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method	9
2	Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.	9
3	Finite difference operator - Interpolation – Newton-Gregory forward and backward interpolation – Newton's divided difference formula – Lagrange's interpolation formula for uneven intervals – Gauss interpolation formula – Numerical differentiation – Numerical Integration – Trapezoidal rule – Simpson's 1/3rd rule.	9
4	Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.	9
5	Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.	9

Exercise No	Practical Component - Internal Assessment marks (IA)-50	No. of Hours
1	Write a program to solve algebraic and transcendental equations by the Bisection method using Python Programming Language.	30
2	Write a program to solve algebraic equations and transcendental by the Newton-Raphson method using Python Programming Language.	
3	Write a program to solve simultaneous linear algebraic equations by Gauss Jordan method using Python Programming Language.	
4	Write a program to find the inverse of a matrix of order n using Python Programming Language.	
5	Write a program to find the determinant of a matrix of order n using Python Programming Language.	
6	Write a program to solve simultaneous linear algebraic equations by Gauss Seidel using Python Programming Language.	
7	Write a program to evaluate definite integral by Trapezoidal rule using Python programming Language.	
8	Write a program to evaluate definite integral by Simpson's 1/3 rule using Python programming Language.	
9	Write a program to solve first order ODE by Euler's method using Python programming Language.	
10	Write a program to solve the first order ODE by Runge Kutta method using Python programming Language.	

Prescribed Text

1	Numerical Method in Science and Engineering, M.K.Venkataraman, National Publication Co, Chennai(2001) Unit 1: Chapter 3 and 4 , Unit 2: Chapter 5, Unit 3: Chapter 6 and 9, Unit 4: Chapter11(Relevant portions) Unit 5: Chapter11(Relevant portions)

Books for Reference

1	Computer oriented Numerical Methods by V.Rajaram –PHI(P)Ltd.

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	ADVANCED ALGEBRA	Nature of the Course	Major 15	Subject Code	MTDSMA15

Credits	4	Semester	7	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Pre requisites if any	Basic concepts of group theory, including groups, subgroups, and cyclic groups. Introductory knowledge of ring theory and polynomial algebra.

Course Outcomes

CO1	Understand and apply the isomorphism theorems and analyze composition series, transpositions, and alternating groups to study group structures.
CO2	Explore group actions and permutation representations, including group actions by left multiplication, and apply Cayley's theorem to solve problems in group theory.
CO3	Analyze group actions by conjugation, understand the class equation, and study automorphisms and the Sylow theorems to investigate group properties, including the simplicity of An
CO4	Examine direct and semi-direct products of groups and apply the fundamental theorem of finitely generated abelian groups to classify abelian group structures.
CO5	Demonstrate understanding of polynomial rings, their properties over fields, unique factorization domains, and apply irreducibility criteria to analyze polynomial structures.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	The isomorphism theorems -Composition Series - Transpositions and Alternating groups.	15
2	Group Actions: Group Actions and Permutation representations-Group acting on themselves by left multiplication-Cayley's theorem	15
3	Group acting on themselves by conjugation -The class equation-Automorphisms-The Sylow theorems- The simplicity of An.	15
4	Direct and semi-direct products and abelian groups: Direct products-The fundamental theorem of finitely generated abelian groups.	15
5	Polynomial rings: Definitions and basic properties- Polynomial rings over fields- Polynomial rings that are unique factorization domains - Irreducible criteria.	15

Prescribed Text

1	David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), John Wiley and sons, 2004. Chapter 3 - Sections 3.3 to 3.5, Chapter 4 - Sections 4.1 to 4.6, Chapter 5 - Sections 5.1 and 5.2, Chapter 9 - Sections 9.1 to 9.4

Books for Reference

1	M. Artin: Algebra, Prentice-Hall of India, 1991
2	I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
3	N. Jacobson: Basic Algebra, Volumes I & II, W. H. Freeman, 1980.
4	S. Lang: Algebra, 3rd edition, Addison-Wesley, 1993

Title of the course	TOPOLOGY	Nature of the Course	Major 16	Subject Code	MTDSMA16

Credits	4	Semester	7	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Pre requisites if any	Students should have a basic understanding of set theory, functions, relations, and real analysis, including limits and continuity.

Course Outcomes

CO1	To introduce the notion of metric spaces and to characterize open sets in the real line
CO2	To study the concept of topological spaces and to study their properties like second count ability and separability
CO3	To discuss in details about compactness of topological spaces and to prove the Tychnoff's theorem with some applications
CO4	To study bout the equivalent versions of compactness in metric spaces
CO5	To discuss some important theorems like Urysohn's lemma and the Tietze extension theorem. Also, we study about connected spaces

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Revision of sets - Functions - Product of sets – Relations – Countable sets – Uncountable sets – Partially ordered sets and lattices – Metric spaces – Definition and examples – Open sets and closed sets in metric spaces – Open subsets of real line	15
2	Topological spaces -- Definitions and examples - Closure and related concepts – Open bases and open sub bases – Separability and second count ability -Lindloff's Theorem	15
3	Compactness – Basic results -- Continuous maps on compact sets - Characterization of compactness by basic and sub basic open covers – Tychon off's theorem – Generalized Heine – Bore theorem.	15
4	Compactness for metric spaces – Sequential compactness - Lebesgue covering lemma - Sequential compactness and compactness coincide on metric spaces - T1spaces - Hausdorff spaces	15
5	Completely regular spaces and normal spaces – Urysohn's lemma and Tietze extension theorem–Connected spaces – Components of a space	15

Prescribed Text

1	G.F.Simmons, an Introduction to Topology and Modern Analysis, McGraw-Hill Kogakusha, Tokyo, 1963

Books for Reference

1	J. R. Munkres, Toplogy, Pearson Education Inc., Second Edition, 2000.
2	Stephen Willard, General Topology, Dover Publication 2004.
3	J. Dugundgi, Toplogy, Allyn and Bacon, Boston, 1966.
4	Fred.H. Croom, Principles of Topology, Dover publications, 2016.

Title of the course	ADVANCED REAL ANALYSIS-I	Nature of the Course	Major 17	Subject Code	MTDSMA17

Credits	4	Semester	7	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Pre requisites if any	A solid understanding of basic real analysis, sequences and series, set theory, and elementary calculus is required. Familiarity with limits, continuity, and basic topological concepts is also expected.

Course Outcomes

CO1	Explain the concepts of infimum, supremum, and metric spaces
CO2	Demonstrate the convergence of series and power series using various tests
CO3	Analyze the topological properties of continuous functions
CO4	Determine the interior point, limit point, closure of subsets of various metric spaces, and also the limits of functions, sequences, and subsequences
CO5	Construct functions that have various combinations of the properties continuity, uniform continuity and differentiability

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Finite, countable and uncountable sets - Metric spaces - Compact sets - Perfect sets - Connected sets - Convergent sequence - Subsequences - Cauchy sequences - Upper and lower limits – Some special sequences.	15
2	Series- Series of non- negative terms - The number e – The root and ratio tests - Power series - Summation by parts - Absolute convergence – Addition and multiplication of series - Rearrangements of series.	15
3	Limits of functions - Continuous functions - Continuity and compactness - Continuity and connectedness - Discontinuities - Monotonic functions - Infinite limits and limits at infinity.	15
4	The derivative of a real function - Mean value theorems – The continuity of derivatives - L'Hospital's rule - Derivatives of higher order - Taylor's theorem - Derivatives of vector – valued functions.	15
5	The Riemann- Stieltjes integral- Definition and existence of the integral - Properties of the integral - Integration and differentiation - Integration of vector- Valued functions - Rectifiable curves - Improper Riemann Integrals.	15

Prescribed Text

1	Walter Rudin, Principles of Mathematical Analysis- McGraw Hill International Editions, Mathematics series, 1976 (Chapters 2-6)

Books for Reference

1	Patrick M. Fitzpatrick, Advanced Calculus, AMS, Pure and Applied Undergraduate Texts, Indian Edition,2nd edition, 2009.
2	Tom Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition, 1985.
3	N.L.Carothers, Real Analysis, Cambridge University Press, 2000.
4	Karl.R.Stormberg, An Introduction to Classical Real Analysis, AMS Chelsea Publishing, 2015.
5	Richard R Goldberg, Methods of Real Analysis, Oxford and IBH Publishing Co. 1970.

Title of the course	ADVANCED REAL ANALYSIS-II	Nature of the Course	Major 18	Subject Code	MTDSMA18

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Pre requisites if any	Basics of real analysis (sequences, series, and continuity). Fundamental concepts of calculus (differentiation, integration). Familiarity with multivariable calculus and linear algebra (matrices, transformations). Understanding of uniform convergence and power series.

Course Outcomes

CO1	To study about functions of bounded variation, double sequence, double series and infinite products
CO2	To study about convergence of sequences and series of functions and their properties
CO3	To prove some famous theorems like Weierstrass approximation theorem and stone Weierstrass theorem
CO4	To study about differentiability of functions of several variables and to prove the contraction mapping theorem.
CO5	To prove the important theorems- The inverse function and the implicit function theorem

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Functions of bounded variation - Double sequences - Double series – Rearrangement theorem for double series- A sufficient condition for the equality of iterated series (Chapter:6 and Sections: 8.20 to 8.23, 8.26 and8.27 of [2])	15
2	(Sequence and Series of functions - Examples - Uniform convergence and Continuity - Uniform convergence and Integration - Uniform convergence and Differentiation - Double sequences and series - Iterated limits- Equicontinuous -Families of Functions – Arzela – Ascoli Theorem (Chapter: 7 of [1], Subsections 7.1 to 7.25)	15
3	The Weierstrauss theorem for algebraic polynomials- The Stone - Weierstrauss Theorem- Power Series - The Exponential and Logarithmic Functions - The Trigonometric Functions - Fourier Series - The Weierstrauss theorem for the Trigonometric polynomials. (Chapter: 7 of [1] subsections: 7.26 to7.33 and chapter 8 of [1])	15
4	Functions of Several Variables - Linear Transformation - Differentiation - The Contraction Principle. (Chapter:9 of [1], Subsections: 9.6 to 9.23)	15
5	The inverse function Theorem - The implicit Function Theorem - The Rank Theorem –Determinants. (Chapter: 9 of [1], Subsections:9.24 to 9.38)	15

Prescribed Text

1	Walter Rudin, Principles of Mathematical Analysis- McGraw Hill International Editions, Mathematics series, 1976
2	Apostol, Mathematical Analysis, Narosa Publishing House, Indian edition,2002.

Books for Reference

1	Patrick M. Fitzpatrick Advanced Calculus, Amer. MATH. Soc. Pine and Applied Undergraduate Texts, Indian Edition, 2009.
2	Kenneth A. Ross, Elementary Analysis, The Theory of Calculus, Springer-Verlag,1980.
3	N. L .Carothers, Real Analysis, Cambridge University Press(2000)
4	G .F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 2017.

Title of the course	ADVANCED LINEAR ALGEBRA	Nature of the Course	Major 19	Subject Code	MTDSMA19

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of linear algebra (vector spaces, matrices, eigenvalues), abstract algebra (fields, rings, modules), and quadratic forms.

Course Outcomes

CO1	Understand the concepts of field theory, splitting fields, algebraic closures, and the algebra of linear transformations.
CO2	Analyze linear transformations, invariant subspaces, and reduction to triangular forms.
CO3	Examine nilpotent transformations, Jordan blocks, and Jordan canonical forms.
CO4	Apply the fundamental theorem on modules over PID, rational canonical forms, and properties of trace, transpose, and determinants.
CO5	Explore Hermitian, unitary, and normal transformations and their applications to real quadratic forms.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Field theory: Splitting fields and Algebraic closures. The Algebra of linear transformations-Characteristic roots- Similarity of linear transformations. Sections – 6.1,6.2, 6.3 [1] and 13.1-13.2 [2]	15
2	Invariant subspaces and matrices. Reduction to triangular forms. Sections – 6.4 and 6.5 [1]	15
3	Nilpotent transformations - Index of nil potency and invariant of nilpotent transformation. Jordan blocks and Jordan forms. Sections – 6.6 and 4.5 [1]	15
4	Modules - Cyclic modules - Fundamental theorem on modules over PID- Rational canonical form- Trace- Transpose and Determinants. Sections - 6.7, 6.8 and 6.9 [1]	15
5	Hermitian - Unitary and Normal transformations - Real quadratic forms. Sections – 6.10 and 6.11 [1]	15

Prescribed Text

1	I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2	Abstract Algebra (Third Edition) by David S. Dummit and Richard M. Foote, (Sections 13.1-13.2)

Books for Reference

1	M. Artin, Algebra, Prentice-Hall of India, 1991
2	N. Jacobson, Basic Algebra, Volumes I & II, W. H. Freeman, 1980.
3	S. Lang, Algebra, 3rd edition, Addison-Wesley, 1993
4	P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition)Cambridge University Press, Indian edition, 1997
5	Kenneth Hoffmann and Ray Kunze, Linear Algebra, (Second edition), Pearson, 20156.S. Friedberg, A. Insel and L. Spence, Linear Algebra, (4th Edition) Pearson, 2015.

Title of the course	DIFFERENTIAL GEOMETRY	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of calculus, linear algebra, and multivariable calculus, including curves, surfaces, and coordinate geometry.

Course Outcomes

CO1	To learn about parametric curves, level curves, and the notion of curvature of plane curves
CO2	To study the properties of space curves, Serret Frenet equations and the four vertex theorem
CO3	To study surfaces, quadratic surfaces, triple orthogonal systems
CO4	To calculate the length of curves on surfaces and surface area
CO5	To study the normal and principle curvature of curves on a surface and Euler's theorem

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Curves- arc length- Reparameterization-Level curves - Curvature - Plane curves. [Sections: 1.1 to 1.4 and Sections 2.1,2. 2.]	15
2	Space curves-Torsion- Serret Frenet equations- Simple closed curves- The Isoperimetric Inequality- The Four Vertex Theorem. [Sections 2.3 and Sections 3.1 to 3.3.]	15
3	Smooth surface- Tangents, normal and orient ability- Examples of surfaces- Quadratic surfaces- Triple orthogonal systems- Applications of Inverse function theorem. [Sections 4.1 to 4.7]	15
4	Lengths of curves on surfaces- First fundamental form- Isometries of surfaces- Conformal mapping of surfaces-Surface area- Equi areal maps and a theorem of Archimedes. [Sections: 5.1 to 5.5]	15
5	The Second Fundamental form- The Curvature of curves on a surface- The normal and principal curvature- Euler's theorem- The geometric interpretation of principal curvatures. [Sections: 6.1 to 6.4]	15

Prescribed Text

1	Andrew Pressley, Elementary Differential Geometry, Springer, 2004.

Books for Reference

1	Christian Bar, Elementary Differential Geometry, Cambridge University Press, 2011.
2	Thomas F. Banchoff and Stephen T. Lovett, Differential Geometry of Curves and Surfaces, A.K Peters/CRC press, 2010.
3	W. Klingenberg, A course in Differential Geometry, Springer-Verlag, New York, 1978.

Title of the course	NUMBER THEORY	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Students are expected to have basic knowledge of elementary number theory, including divisibility, primes, and congruences. Familiarity with fundamental algebraic techniques, proof methods (especially mathematical induction), and elementary functions is essential. A basic understanding of real numbers and irrationality is also recommended.

Course Outcomes

CO1	Understand the fundamental concepts of divisibility, prime numbers, and their properties.
CO2	Solve linear and higher-degree congruences, including those with prime power moduli.
CO3	Analyze quadratic residues and apply the law of quadratic reciprocity and the Jacobi symbol.
CO4	Compute and interpret arithmetic functions, recurrence functions, and apply the Möbius inversion formula; understand the irrationality of certain numbers.
CO5	Represent irrational numbers using infinite continued fractions and examine the properties of special quadratic surds.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Divisibility: Introduction -Divisibility- Primes.	15
2	Solution of congruences – Congruences of higher degree – prime power moduli.	15
3	Quadratic Residues, Quadratic Reciprocity Law, Jacobi Symbol.	15
4	Arithmetic functions- Recurrence functions, Mobius Inversion Formula, Irrational numbers, Irrationality of n^{th} root of N, e, and pi.	15
5	Continued fractions and its convergence, representation of an irrational number by an infinite continued fraction. Some special quadratic surds.	15

Prescribed Text

1	An Introduction to the Theory of Numbers, by I. Niven, H.S. Zuckerman and H.L. Montgomery , New York, John Wiley and Sons, Inc., 2004, 5th Ed. Unit I Section :1.1-1.3, Unit II Section :2.1-2.11, Unit III Section:3.1-3.3, Unit IV Section:4.1-4.3, Unit V Section :5.6-5.11

Books for Reference

1	T.M. Apostol – Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi.
2	G.H. Hardy and E.M. Wright- An Introduction to the Theory of Numbers, Oxford University Press, 1979, 5th Ed.

Title of the course	DISCRETE DYNAMICAL SYSTEMS	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of calculus, differential equations, and linear algebra

Course Outcomes

CO1	Understand the concepts of orbits, phase portraits, periodic points, and Sarkovskii's theorem.
CO2	Analyze attracting and repelling periodic points, differentiability, bifurcations, and the logistic map.
CO3	Explain symbolic dynamics, Devaney's definition of chaos, and topological conjugacy.
CO4	Apply Newton's method and numerical solutions of differential equations.
CO5	Explore the dynamics of complex functions, the quadratic family, and the Mandelbrot set

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Orbits - Phase portraits- Periodic points and stable sets. Sarkovskii's theorem	15
2	Attracting and repelling periodic points- Differentiability and its implications – Parametrized family of functions and bifurcations- The logistic map.	15
3	Symbolic dynamics - Devaney's definition of Chaos - Topological Conjugacy.	15
4	Newton's method-Numerical solutions of differential equations.	15
5	The dynamics of Complex functions- The quadratic family and the Mandelbrot set.	15

Prescribed Text

1	Richard A. Holmgren, A First Course in Discrete Dynamical Systems, Springer Verlag (1994). Unit-I [Chapters: 1, 2, 4 and 5], Unit-II [Chapters: 6, 7 and 8], Unit-III [Chapters: 9, 10 and 11], Unit-IV [Chapters: 12 and 13], Unit-V [Chapters 14 and 15].

Books for Reference

1	Robert L.Devaney, A First Course in Chaotic Dynamical Systems, Addison-Wesley Publishing Company, Inc. 1992.

Title of the course	NUMERICAL ANALYSIS FOR ORDINARY DIFFERENTIAL EQUATIONS	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of calculus, ODEs, linear algebra

Course Outcomes

CO1	Apply numerical methods like Euler's method, Trapezoidal rule, and Theta method to solve ordinary differential equations (ODEs).
CO2	Implement Adams-Bashforth methods and Backward Differentiation Formulas for solving ODEs, and analyze their order and convergence.
CO3	Utilize Gaussian quadrature, explicit and implicit Runge-Kutta methods, and the Collocation method for numerical integration and solving ODEs.
CO4	Analyze the stability and convergence of numerical methods, particularly for stiff equations, and understand the concept of A-stability.
CO5	Demonstrate error control techniques, and apply the Milne device and embedded Runge-Kutta methods for adaptive step-size integration.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Euler's method , Trapezoidal rule, Theta method.	15
2	Adams - Bashforth method, Order and convergence, Backward differentiation formula	15
3	Gaussion quadrature, Explicit Runge - Kutta scheme, Implicit Runge Kutta scheme Collocation.	15
4	Stiff equations, Linear stability domain and A- Stability -- A-stability of RK and multistep methods.	15
5	Error Control, Milne Device, Embedded Runge Kutta method	15

Prescribed Text

1	Arieh Iserles, A First Course in the Numerical Analysis of Differential Equations, Cambridge University press, 2nd edition, 2008.

Books for Reference

1	Richard L. Burden and J.Douglas faires, Numerical Analysis(9th Edition), Cengage Learning India, 2012

Title of the course	LATTICE THEORY	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22
Credits	4	Semester	8	Type of course	Theory
No. of Hours of Teaching	75				
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic knowledge of calculus, differential equations, linear algebra, and introductory set theory. Familiarity with order relations, functions, and algebraic structures is recommended for understanding Lattice Theory concepts.				

Course Outcomes

CO1	Understand fundamental concepts of posets, duality, monotone maps, and chain conditions.
CO2	Apply transfinite induction, ordinal, and cardinal arithmetic to well-ordered sets and complete posets.
CO3	Analyze lattice structures, semilattices, closure operators, and lattice homomorphisms.
CO4	Characterize modularity, semi-modularity, partition lattices, and distributive lattices.
CO5	Explore Boolean lattices, Boolean algebras, Boolean rings, and their homomorphisms.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Basic Definitions – Duality – Monotone Maps – Down-Sets and the Down Map – Height and Graded Posets – Chain Conditions – Chain Conditions and Finiteness – Dilworth's Theorem – Symmetric and Transitive Closures – The Poset of Partial Orders.	15
2	Well-Ordered Sets – Ordinal Numbers – Transfinite Induction – Cardinal Numbers – Ordinal and Cardinal Arithmetic – Complete Posets.	15
3	Closure and Inheritance – Semilattices – Arbitrary Meets Equivalent to Arbitrary Joins – Lattices – Meet Structures and Closure Operators – Properties of Lattices – Irreducible Elements – Completeness – Sublattices – Denseness – Lattice Homomorphisms – Ideals and Filters – Prime and Maximal Ideals	15
4	Quadrilaterals – The definitions and Examples – Characterizations – Modularity and Semi modularity – Partition Lattices and Representations – Distributive Lattices.	15
5	Boolean Lattices – Boolean Algebras – Boolean Rings – Boolean Homomorphisms – Characterizing Boolean Lattices – Complete and Infinite Distributivity	15

Prescribed Text

1	Steven Roman, Lattices and Ordered Sets, Springer Science, 2008. Chapters: 1,2,3,4, and 5.

Books for Reference

1	Garrett Birkhoff, Lattice Theory, American Mathematical Society, Colloquim Publications, 1948.

Title of the course	INTEGRAL TRANSFORMS AND THEIR APPLICATIONS	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of differential equations, Fourier transforms, and mathematical methods for solving ordinary and partial differential equations.

Course Outcomes

CO1	To study about Laplace transform and Inverse Laplace transform
CO2	To study about Applications of Laplace transform
CO3	To study Hankel transform with properties and to solve the PDE
CO4	To study Mellin transform with properties and to solve the summation series
CO5	To study and understand about Z- transform with properties and to apply for solving the difference equations

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Laplace transforms - Definition and Examples, Basic Properties of Laplace Transforms, The Convolution Theorem and Properties of Convolution, Differentiation, and Integration of Laplace Transforms. The Inverse Laplace Transform and Examples, Tauberian Theorems and Watson's Lemma.	15
2	Applications of Laplace Transforms to the Solutions of Ordinary Differential Equations, Partial Differential Equations, Initial and Boundary Value Problems.	15
3	Introduction, The Hankel Transform and Examples, Operational Properties of the Hankel Transform, Applications of Hankel Transforms to Partial Differential Equations.	15
4	Introduction, Definition of the Mellin Transform and Examples, Basic Operational Properties of Mellin Transforms, Applications of Mellin Transforms, Application of Mellin Transforms to Summation of Series.	15
5	Introduction, Dynamic Linear Systems and Impulse Response, Definition of the Z Transform and Examples, Basic Operational Properties of Z Transforms, The Inverse Z Transform and Examples, Applications of Z Transforms to Finite Difference Equations.	15

Prescribed Text

1	Lokenath Debnath and Dambaru Bhatta, Integral Transforms and Their Applications, Third Edition, CRC Press, Taylor and Francis Group, A Chapman and Hall Book, 2015. Unit I: Laplace Transforms (Sections-3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8) ,Unit II: Applications of Laplace Transforms (Sections-4.1, 4.2, 4.3), Unit III: Hankel Transforms (Sections-7.1, 7.2, 7.3, 7.4), Unit IV: Mellin Transforms (Sections- 8.1, 8.2, 8.3, 8.4, 8.6),Unit V: Z Transforms (Sections-12.1, 12.2, 12.3, 12.4, 12.5, 12.6)

Books for Reference

1	Ian N. Snedden, The Use of Integral Transforms, McGraw Hill, 1972
2	B. Davies, Integral Transforms and Their Applications, Springer, Texts in Applied Mathematics 41, Third Edition,2009.
3	Alexander D. Poularikas, Transforms and Applications Handbook, Third Edition, CRC Press, Taylor and Francis Group, 2010.

Title of the course	INTEGRAL EQUATIONS	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22
Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic knowledge of ordinary differential equations (ODEs), boundary value problems (BVPs), and mathematical methods for solving integral equations.				

Course Outcomes

CO1	Apply the classification of integral equations to solve initial value problems for ODEs.
CO2	Solve boundary value problems for ODEs and elliptic PDEs and understand Abel's problem.
CO3	Transform second-order ODEs into integral equations and address singular boundary value problems.
CO4	Solve integral equations of the second kind, especially those with degenerate kernels.
CO5	Apply operators and Neumann series approaches to solve integral equations.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Introduction - Classification of integral equation - examples - IVP for ODE.	15
2	BVP for ODE - BVP for elliptic PDE - Abel's problem.	15
3	Second order ODE and integral equations -Differential equation theory - initial value problems - Boundary value problems - Singular boundary value problems.	15
4	Integral equations of the second kind - Introduction - Degenerate kernels - a different approach.	15
5	Operators - Newmann series.	15

Prescribed Text

1	Porter and Stirling, Integral equations, pp 1-94. A practical treatment from spectral theory to applications. - Cambridge: Cambridge University Press, 1996.

Books for Reference

1	Harry Hochstadt, Integral Equations, Wiley Interscience Publication, New York

Title of the course	PARTIAL DIFFERENTIAL EQUATIONS	Nature of the Course	Major 20/21/22	Subject Code	MTDSMA 20/21/22

Credits	4	Semester	8	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of ordinary differential equations, multivariable calculus, and linear algebra is required.

Course Outcomes

CO1	Understand the relation between the theory and modelling in the problems arising in various fields, such as economics, finance, applied sciences, etc
CO2	Enhance their mathematical understanding in representing solutions of partial differential equations.
CO3	Classify the partial differential equations and transform them into canonical form
CO4	Determine the solution representation for the three important classes of PDEs, such as Laplace, Heat, and wave equations, by various methods.
CO5	Formulate fundamentals of partial differential equations, like Green's function, maximum principles, Cauchy problem, to take a research career in the area of partial differential equations

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	First Order PDEs : Surfaces and their Normals, Curves and tangents - Genesis of first order PDE- Classification of Integrals- Linear equations of first Order - Integral surface passing through a curve – Cauchy problem for first order PDE – Orthogonal Surfaces. Non-linear first order PDEs: Compatible systems- Solutions of Quasi linear equations, Charpit's method- Special Types of Charpits Method, -Integral surfaces through a given The Cauchy problem for Quasi Linear case and nonlinear first order PDEs.	15
2	Second Order PDEs: Genesis of Second Order PDEs- Classification of second order PDEs- Canonical forms of Hyperbolic, Elliptic, and parabolic type PDEs, Linear PDE with constant coefficients – Method of finding CF and particular integral- Homogeneous linear PDE	15
3	Hyperbolic PDEs / Wave Equation: Derivation of One –One-dimensional wave equations- Initial Value Problem – D'Alembert Solution, Method of separation of variables, Forced Vibration, Solution of non-homogeneous equation, Uniqueness of solution of wave equation.	15
4	Elliptic PDEs/Laplace Equations: Derivation of Laplace equations & Poisson equation- Boundary value problems- Properties of Harmonic functions- Spherical Mean, Mean value theorem- Maximum and minimum principles- Separation of variables- Dirichlet problem and Neumann problems for a rectangle and circle (Up to 2.10 in Text Book 1). Application - Irrotational Flow of an Incompressible Fluid (Section 2.13)	15
5	Heat Equations: Diffusion Equation, Boundary Conditions - Elementary solution- Solution by separation of variables- Classification in n-variables- Families of equipotential surfaces	15

Prescribed Text

1	K. Shankara Rao, Introduction to Partial Differential Equations, PHI Publications, Edition. 2011.
2	T. Amarnath, An Elementary Course in Partial Differential Equations, Narosa Publishing House, 2010.

Books for Reference

1	I. N. Sneddon, Elements of Partial Differential Equations, McGraw Hill, International Edition, 1986.
2	F. John, Partial Differential Equations, Springer Verlag, 1975.
3	Lawrence C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, 1998.

LIST OF MINOR COURSES-STREAM I

(within the Department and other disciplines**)**

Title of the course		**FOUNDATIONS OF DATA SCIENCE - I**		**Nature of the Course**		**Minor 1**	**Subject Code**	**MTDSMI01**
Credits	**4**	**Semester**	**1**	**Type of course**	**Theory**	**No. of Hours of Teaching**		**75**
Internal Assessment Marks (IA)		**25**	**End Semester Examination (ESA)**			**75**	**Duration of ESA**	**3 hrs**
Course Prerequisites if any		Basic problem-solving skills						

Course Outcomes	
CO1	Comprehend the fundamental concepts of data science.
CO2	Solve problems in Probability and Statistics
CO3	Solve fundamental problems in Matrices and comprehend the application of matrices
CO4	Use databases for structured and unstructured data
CO5	Summarize the steps in the Data Science life cycle

Unit No	**Course Content**	**No. of Hours**
	Theory Component (45 Hours)	
1	Introduction: Need for Data Science – Data Science Process – Business Intelligence and Data Science – Prerequisites for a Data Scientist. Exploratory Data Analysis – Data Format, Types of EDA – Univariate, multivariate non-graphical, graphical EDA	**9**
2	Probability and Statistics: Understanding Probability – Math – Binomial distribution Data – descriptive vs Inferential – Population , Sample, Bias – Descriptive statistics – Inferential Statistics – T Distributions	**9**
3	Linear Algebra: Vector – Linear Transformations – Matrix multiplication – Determinants – Types of matrices – system of equation and inverse matrices – Eigen vector , Eigen values	**9**
4	Databases for Data Science: Structured Query Language (SQL): Data Munging, Filtering, Joins, Aggregation, Window Functions, Ordered Data, No-SQL, Document Databases, Wide-column Databases and Graphical Databases.	**9**
5	Data Science Methodology: Analytics for Data Science – Examples of Data Analytics – Data Analytics Lifecycle: Data Discovery, Data Preparation, Model Planning, Model Building.	**9**

Exercise No	**Practical Component (Internal Assessment 25 Marks)**	**No. of Hours**
1	Download, and install NumPy, SciPy, and pandas in Python.	**30**
2	Build a data frame using pandas from a CSV file.	
3	Write a program for finding the frequency, Mean, Median, Mode, Variance, and Standard Deviation of data using Python pandas data frame.	

4	Plot a graph for probability distribution using Python (Normal Distribution).	
5	Perform data analysis using SciPy .	
6	Create a database and establish relationships between tables.	
7	Create view to extract details from two or more tables.	

Prescribed Text	
1	Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, Fundamentals of Data Science , CRC Press, 1st Edition, 2022. Unit-1(part 1, chapter1), Unit 4(Part 1, chapter 3), Unit 5(Part 2, Chapter 4)
2	Howard J.Seltman, Experimental Design and Analysis, CMU, 2018. Unit 1 (Chapter 4)
3	Thomas Nield, Essential Math for Data Science, O'Reilly Media Inc.,2022. Unit 2(Chapters 2, 3), Unit 3(Chapter 4)

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	FOUNDATIONS OF DATA SCIENCE - II	Nature of the Course	Minor 2	Subject Code	MTDSMI02

Credits	4	Semester	2	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic problem-solving skills

Course Outcomes

CO1	Understand the concepts of regression analysis
CO2	Explore Data Science Tools
CO3	Explain the fundamental machine learning algorithms
CO4	Apply Data Analytics in Text Mining
CO5	Perform Data Visualization

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Regression Analysis: Linear – Logistic – Multinomial logistic regression – Time Series Models	9
2	Machine Learning: Introduction to Decision Trees- Naïve Bayes- Support Vector Machines- Nearest Neighbour Learning- Clustering- Confusion Matrix.	9
3	Data Analytics on Text: Text Mining - Text Analytics - Natural Language Processing-Major Components - Stages - Statistical Processing - Applications	9
4	Data Science Tools: Python : Basics, Library – R : Reading and Getting Data	9
5	Data Visualization using Tableau: Introduction - Dimensions, measures, descriptive statistics - basic charts - Dashboard Design and principles - Special charts – Integrate Tableau with Google sheet.	9

Exercise No	Practical Component (Internal Assessment 25 Marks)	No. of Hours
1	Program to calculate regression coefficient	30
2	Program to count word frequency	
3	Install NLTK library and perform simple text processing and analysis tasks	
4	Program to process the text (Identifying stop words, Stemming, Lemmatizing).	
5	Practice plotting different charts using Tableu	

Prescribed Text

1	Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, Fundamentals of Data Science, CRC Press, 1st Edition, 2022. Unit 1(chapter 5, sec 5.1), Unit 2(chapter 5, sec 5.2), Unit 3(Chapter 6), Unit 4 (Chapter 7 and 8), Unit 5(Chapter 11)

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	EXPLORATORY DATA ANALYSIS (Practical)	Nature of the Course	Minor 3	Subject Code	MTDSMI03

Credits	4	Semester	3	Type of course	Practical	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	50	End Semester Examination (ESA)	50	Duration of ESA	3 hrs

Course Prerequisites if any	Python Programming

Course Outcomes

CO1	Perform data loading, transformation, and preliminary analysis for real-world data
CO2	Create charts and graphs to effectively communicate and interpret patterns in data during Exploratory Data Analysis.
CO3	Apply advanced statistical measures to describe and interpret datasets, including measures of central tendency and dispersion
CO4	Critically evaluate and draw meaningful conclusions from the analysis results.
CO5	Demonstrate proficiency in handling time series datasets and performing Time Series Analysis (TSA) using Python.

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Exploratory Data Analysis: Fundamentals- Understanding Data Science – Significance of EDA – Making sense of Data – Comparing EDA with classical and Bayesian analysis– Software tools available for EDA.	9
2	Visual aids for EDA: Line – Bar charts – Scatter Plot – Area Plot – Pie – Table chart – Polar chart – Histogram – Lollipop chart, EDA with Personal Email -Technical requirements –Loading the data set – data transformation -Data Analysis	9
3	Data Transformation: Managing Database – Transformation Techniques – Benefits, Descriptive Statistics, Understanding statistics – Measures of central tendency – Measures of dispersion.	9
4	Grouping Datasets: Understanding groupby() – Groupby mechanics – Data aggregation – Pivot tables & Cross-tabulations. Correlation Understanding correlation – Types of analysis – Multivariate analysis using Titanic dataset.	9
5	Model Development and Evaluation: Hypothesis Testing and Regression, Model Development and Evaluation EDA on Wine Quality Data Analysis. Disclosing – Red Wine Analysis	9

Exercise No	Practical Component- Internal Assessment marks (IA)-50	No. of Hours
1	Download, Install and practice opensource tools for EDA – Eg. WEKA.	30
2	Visualize the data using various graphs .	
3	Perform histogram analysis using NumPy, Matplotlib, pandas.	
4	Program to generate different charts and plots.	
5	Program to generate pivot using groupby() method.	
6	Perform Time Series analysis and test with with a predictive model.	

7	Program to identify the correlation of the features/parameters in the Titanic Dataset.	
8	Perform EDA on Wine Data .	
9	Demonstrate different visualizations based on Exercise 7.	

Prescribed Text	
1	Suresh Kumar Mukhiya, Usman Ahmed, Hands-On Exploratory Data Analysis with Python , PACKT Publishing , 2020. Unit 1 (Chapter 1), Unit 2(Chapters 2 and 3), Unit 3(Chapters 4 and 5), Unit 4(Chapters 6 and 7), Unit 5(Chapter 9, 11).

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	DATA WRANGLING WITH R (Practical)	Nature of the Course	Minor 4	Subject Code	MTDSMI04

Credits	4	Semester	4	Type of course	Practical	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	50	End Semester Examination (ESA)	50	Duration of ESA	3 hrs

Course Prerequisites if any	Foundations of Data Science, R programming

Course Outcomes

CO1	Demonstrate the ability to write and execute R code efficiently for data manipulation.
CO2	Apply data wrangling skills to various datasets, understand the data generation process, interpret different data types, and effectively use data to address analytical queries.
CO3	Utilize core functions of dplyr for efficient data manipulation, sequential operations, grouping, and joining of data frames
CO4	Access and integrate data from databases and web APIs using R
CO5	Design and create interactive visualization with ggplot2

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Introduction : Setting the computer – Command line Managing Projects Version Control – Markdown	9
2	R Fundamentals : Introduction – Functions – Vectors – Lists	9
3	Data Wrangling : Understanding Data - Data Frames - Manipulating Data With dplyr - Reshaping Data with tidyr	9
4	Data Wrangling: Accessing Databases – Accessing Web APIs	9
5	Data Visualization: Designing Data Visualizations - Creating Visualizations with ggplot2 – Interactive Visualization in R	9

Exercise No	Practical Component - Internal Assessment marks (IA)-50	No. of Hours
1	Practice version control using GitHub	30
2	Perform operations using Data frames	
3	Perform sequential operations using dplyr	
4	Practice reshaping educational statistics using tidyr	
5	Download, install, practice Plotly, Rbokeh, Leaflet Package	
6	Perform interactive visualization Using Seattle dataset	
7	Demonstrate visualization using Plotly, Rbokeh, and Leaflet Packages	

Prescribed Text

1	Michael Freeman and Joel Ross, Programming Skills for Data Science: Start Writing code to Wrangle, Analyze, and Visualize Data with R , Addison-Wesley, 2018. Unit 1(Chapters 1, 2, 3, 4), Unit 2(Chapters 5, 6, 7, 8), Unit 3(Chapters 9, 10, 11, 12), Unit 4(Chapters 13,14), Unit 5(Chapters 15,16, 17),

Books for Reference

1	Bradley C. Boehmke, Data Wrangling with R, Springer International Publishing Switzerland 2016
2	Rafael A Irizarry, Introduction to Data Science: Data Wrangling and Visualization with R, Data Science Series, CRC Press,2024.

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	PROBABILITY AND STATISTICS	Nature of the Course	Minor 5	Subject Code	MTDSMI05

Credits	4	Semester	5	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESA)	75	Duration of ESA	3 hrs

Course Prerequisites if any	Basic Knowledge of Probability

Course Outcomes

CO1	Understand the fundamental concepts of probability, including sample space, events, and rules for calculating probabilities.
CO2	Analyze and interpret random variables and their probability distributions, both discrete and continuous.
CO3	Calculate mathematical expectations, including mean, variance, and covariance, and apply Chebyshev's theorem to assess variability.
CO4	Explore and apply various discrete and continuous probability distributions, including binomial, Poisson, and normal distributions, in real-world scenarios.
CO5	Apply statistical methods to sampling distributions, including the Central Limit Theorem, t-distribution, and F-distribution, for data analysis and hypothesis testing.

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Probability: Sample Space - Events - Counting Sample Points - Probability of Event - Additive Rules - Conditional Probability - Independence and Product Rule - Bayes Rule	9
2	Random Variables and Probability distributions: Concept - Discrete probability distributions - Continuous probability distributions - Joint Probability distributions	9
3	Mathematical Expectation: Mean - Variance - Covariance - Means and Variances of Linear Combinations of Random Variables- Chebyshev's Theorem	9
4	Discrete and continuous Probability Distributions: Binomial and Multinomial Distributions- Hypergeometric Distribution- Poisson Distribution and the Poisson Process- Continuous Uniform Distribution- Normal Distribution- Areas under the Normal Curve- Applications of the Normal Distribution	9
5	Fundamental Sampling Distributions and Data Descriptions: Random Sampling- Some Important Statistics- Sampling Distributions- Sampling Distribution of Means and the Central Limit Theorem- Sampling Distribution of S^2 - t-Distribution- F-Distribution	-9

Exercise No	Practical Component (Internal Assessment 25 Marks)	No. of Hours
1	Implement Bayes' Theorem	
2	Simulate random and Continuous variable	

3	Implement Binomial distribution	**30**
4	Implement Poisson Distribution	
5	Implement Normal Distribution	
6	Implement t-Distribution- F-Distribution	
7	Implement F-Distribution	

	Prescribed Text
1	R.E.Walpole, R.H.Myers, S.L.Myers, Keying Ye, Probability and Statistics for Engineers and Scientists, Prentice Hall, 9th Edition, 2012 Unit 1(Chapter 2, Sections 2.1-2.7), Unit 2(Chapter 3, Sections 3.1-3.4), Unit 3(Chapter 4, Sections 4.1-4.4), Unit 4(Chapters 5, 6, Sections 5.2, 5.3, 5.5, 6.1-6.4), Unit 5(Chapter 8, Sections 8.1-8.7)
	Books for Reference
1	Hogg, R.V. , Mc Kean J W and Craig, A.T.,Introduction to Mathematical Statistics, Pearson, 6th Edition, 2021

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	INTERACTIVE DATA VISUALIZATION (Practical)	Nature of the Course	Minor 6	Subject Code	MTDSMI06

Credits	4	Semester	6	Type of course	Practical	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	50	End Semester Examination (ESE)	50	Duration of ESA	3 hrs

Course Prerequisites if any	Foundations of Data Science

Course Outcomes

CO1	Understand the foundational principles of visualization and the relationship between visualization and other fields.
CO2	Apply various techniques to visualize spatial and geospatial data effectively.
CO3	Develop visualizations for time-oriented and multivariate data using different approaches.
CO4	Explore methods for visualizing trees, graphs, networks, and textual data representations.
CO5	Implement interaction techniques to create interactive data visualizations across various data spaces.

Unit No	Course Content	No. of Hours
	Theory Component (45 Hours)	
1	Introduction: Meaning of Visualization - History of Visualization -Relationship between Visualization and Other Fields-The Visualization Process - The Role of Cognition- The Scatterplot. Visualization Foundations: The Visualization Process in Detail - Semiology of Graphical Symbols - The Eight Visual Variables - Historical Perspective - Taxonomies	9
2	Visualization Techniques for Spatial Data: One-Dimensional Data- Two-Dimensional Data -Three-Dimensional Data -Dynamic Data - Combining Techniques. Visualization Techniques for Geospatial Data: Visualizing Spatial Data -Visualization of Point Data -Visualization of Line Data -Visualization of Area Data.	9
3	Visualization Techniques for Time-Oriented Data: Introduction – Definitions -Visualizing Time -Time Bench. Visualization Techniques for Multivariate Data: Point-Based Techniques-Line-Based Techniques -Region-Based Techniques - Combinations of Techniques.	9
4	Visualization Techniques for Trees, Graphs, and Networks: Displaying Hierarchical Structures-Displaying Arbitrary Graphs/Networks- Other Issues-Related Readings	9

	Text and Document Visualization: Introduction-Levels of Text Representations-The Vector Space Model-Single Document Visualizations -Document Collection Visualizations	
5	Interaction Concepts: Interaction Operators -Interaction Operands and Spaces -A Unified Framework. Interaction Techniques: Screen Space -Object Space -Data Space -Attribute Space-Data Structure Space-Visualization Structure Space-Animating Transformations -Interaction Control	**9**

Exercise No	**Practical Component- Internal Assessment marks (IA)-50**	**No. of Hours**
1	Scatterplot Basics**:** Create a scatterplot to visualize the relationship between two variables using Matplotlib and Seaborn.	**30**
2	Visual Variables Demonstration**:** Demonstrate the eight visual variables (e.g., position, size, shape, color) by creating sample visualizations.	
3	One-Dimensional Data Visualization**:** Plot a line graph to visualize temperature variations over a week using Matplotlib.	
4	Geospatial Data Visualization**:** Plot geographical data (e.g., locations of cities) on a world map using the folium library.	
5	Time Series Data Visualization**:** Visualize daily sales data for a month using a time series line chart with Matplotlib.	
6	Multivariate Data Visualization**:** Create a pair plot for a dataset with multiple variables using Seaborn to show relationships.	
7	Tree Visualization**:** Visualize a hierarchical structure (e.g., a family tree) using the networkx library.	
8	Text Data Visualization**:** Create a word cloud from a given text document using the wordcloud library.	
9	Interactive Scatterplot**:** Build an interactive scatterplot using Plotly, allowing users to zoom and hover over points to see details.	
10	Animated Transformation**:** Create an animated bar chart to show population changes over time using Matplotlib or Plotly.	

Prescribed Text

1	Matthew Ward, Georges Grinstein, Daniel Keim, Interactive Data Visualization – Foundations, Techniques and Applications, CRC Press, 2nd Edition, 2015. Unit 1(Chapters 1,4, sections 1.1-1.5, 1.7, 4.1-4.5), Unit 2(Chapters 5,6, sections 5.1-5.5, 6.1-6.4), Unit 3(Chapters 7,8, sections 7.1-7.4, 8.1-8.4), Unit 4(Chapters 9,10, sections 9.1-9.4, 10.1-10.5), Unit 5(Chapters 11, 12, sections 11.1-11.3, 12.1-12.8)

Books for Reference

1	Abha B, Sharath C G, Shubhangi H, Anshu K, Interactive Data Visualization with Python, Packt Publishing, 2nd Edition, 2020.

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	CALCULUS OF VARIATIONS	Nature of the Course	Minor 7	Subject Code	MTDSMI07

Credits	4	Semester	7	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	A foundational understanding of calculus, ordinary differential equations, linear algebra, and basic concepts of mathematical analysis.

Course Outcomes

CO1	To learn about functionals and solving related variational problems by Euler's equation
CO2	To understand and solve the variational problems functionals depending on higher order derivatives
CO3	To understand and solve the variational problems functionals depending on higher order derivatives
CO4	To study and understand about canonical form of Euler equations and other transformations, Noether's Theorem and conservation laws
CO5	To learn about the second variation and Legendre conditions of a functional

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Functionals- some simple variational problems variation of a functional- A necessary condition for an extremum- The simplest variational problem's The case of several variables simple variable endpoint problem- The variational derivative- Invariance of Euler's equation.[Chapter-1]	15
2	The fixed endpoint problem for n-unknown functions - Variational problem in parametric form- Functionals depending on higher order derivatives-Variational problems with subsidiary conditions. [Chapter-2]	15
3	The general variational of a functional- derivation of the basic formula- End points lying on two given curves or surfaces- Broken extremals- The Weierstrass Erdmann conditions. [Chapter-3]	15
4	The canonical form of Euler equations- First integrals of the Euler equations- The Legendre transformation- Canonical transformations- Noether's Theorem- The principle of least action- Conservation laws- The Hamilton Jacobi equation- Jacobi theorem.[Chapter-4]	15
5	The second variation of a functional- The formula for the second variation, Legendre conditions- Sufficient conditions for a weak extremum. [Chapter-5]	15

Prescribed Text

1	I.M. Gelfand and S.V.Fomin, Calculus of Variations, Dover Publications, 2000

Books for Reference

1	A.S. Gupta, Calculus of Variations with Applications, Prentice-Hall of India, 2008.
2	M.L. Krasnov, G.I. Makarenko and A.I. Kiselev, Problems and Exercises in the Calculus of Variations, Mir Publishers, Moscow 1975

Title of the course	DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS	Nature of the Course	Minor 8	Subject Code	MTDSMI08

Credits	4	Semester	7	Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Pre requisites if any	Knowledge of differential equations (first and second order). Basic concepts of linear algebra (matrix operations, eigenvalues, eigenvectors). Familiarity with calculus (series expansions, integration, differentiation).

Course Outcomes

CO1	Analyze qualitative properties of solutions to differential equations, apply the Sturm Separation and Comparison theorems, and solve problems involving eigenvalues, eigen functions, and vibrating strings.
CO2	Solve Gauss hypergeometric and confluent hypergeometric equations, and use integral, differentiation, transformation, and summation formulas for these functions.
CO3	Explore Legendre polynomials, Bessel functions, and the Gamma function, and study their properties and applications.
CO4	Solve linear systems of differential equations with constant coefficients and examine their homogeneous solutions.
CO5	Understand the existence and uniqueness of solutions, and apply the method of successive approximations and Picard's theorem for solving differential equations.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Qualitative properties of solutions – The Sturm Separation Theorem, The Sturm comparison theorem– Eigen values and Eigen functions and vibrating string. Series solutions of first order equations – Second order linear equations – Ordinary points - Regular singular points. Chapter-4, Sections: 25, Chapter-5, Sections: 26, 27, 28, 29, 30 & Chapter -7, Sections: 40 of [1].	15
2	Gauss Hypergeometric equations. Gauss's hypergeometric and Confluent hypergeometric functions, integral representations, differentiation formulas, transformation formulas, summations formulas. Chapter-5, Sections: 31 of [1] & Chapters: 4 & 7 of [2].	15
3	Legendre polynomials – Properties of Legendre polynomials – Bessel functions- The Gamma function - Properties of Bessel Function. Chapter-8, Sections: 44, 45, 46 47 of [1].	15
4	Linear systems – Homogeneous linear system with constant coefficients. Chapter-10, Sections: 55, 56 of [1].	15
5	The existence and uniqueness of solutions – The method of successive approximations – Picards's theorem. Chapter-13, Sections: 68, 69 of [1].	15

Prescribed Text

1	G. F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Edition, McGraw Hill Education(India) Company, 2003. Sections: 22-30, 32-35, 37-35 55- 56.
2	E. D. Rainville, Special functions, Macmillan, New York, 1960.

Books for Reference

1	Earl Coddington and Norman Levinson, Theory of ordinary Differential equations, TATA McGraw Hill, 2017
2	N. M. Temme, Special functions: An introduction to the classical functions of mathematical physics, John Wiley& Sons, New York, 1996.

LIST OF MINOR COURSES-STREAM II

(Arts, Commerce and Humanities)

Title of the course		**COMPUTATIONAL SKILLS**			**Nature of the Course**		**Minor**		**Subject Code**		
Credits	**4**	**Semester**		**Type of course**		**Theory**	**No. of Hours of Teaching**			**75**	
Internal Assessment Marks (IA)		**25**	**End Semester Examination (ESE)**			**75**	**Duration of ESE**			**3 hrs**	
Course Prerequisites if any		Basic mathematical and problem-solving skills									

Course Outcomes	
CO1	Solve problems involving ratios, proportions, percentages, and interest calculations.
CO2	Apply matrix operations and determinants to solve linear equations and multivariable problems.
CO3	Identify and analyze various types of functions and their real-world applications in business.
CO4	Develop logical reasoning skills to solve problems involving analogies, blood relations, and other reasoning concepts.
CO5	Demonstrate proficiency in quantitative aptitude and basic mathematics for competitive exams.

Unit No	**Course Content**	**No. of Hours**
	Theory Component (75 Hours)	
1	Ratio, Proportion, and Percentage: Ratio: Definition – Continued Ratio – inverse Ratio. Proportion – Continued Proportion – Direct Proportion – Inverse Proportion Variation – Inverse Variation – Joint Variation Percentage: Meaning and computation of percentage. Interest: Simple interest – compound interest (reducing balance and flat interest rate) – equated monthly instalments (EMI) – Problems.	**15**
2	Matrices and Determinates (up-to order 3 only): Multivariable data - Definition of a Matrix; Types of matrices; Algebra of matrices; Determinates– Ad-joint of a matrix – Inverse of a matrix via ad-joint matrix– homogeneous system– Solution of a non-homogeneous system of linear equations (not more than three variables)– Conditions for existence and uniqueness of solution– Solution using the inverse of the coefficient matrix – Problems	**15**
3	Functions: (To identify and define the relationships that exist among the business variables). Definition of function, constants, variables, continuous real variable, domain or interval –Types of functions – one valued function – Explicit function – Algebraic functions – Polynomial functions– Absolute value function– Inverse function – Rational and irrational function – Monotone function – Even and odd function – Supply/demand function – Cost function – Total revenue function– Profit function – Production function – Utility function – Consumption function.	**15**

4	Arithmetical Logical Reasoning: Analogy Blood Relation Directional Sense Number and Letter Series Coding-Decoding, Calendars, Clocks, Venn Diagrams, Seating Arrangement Syllogism, Mathematical Operations	**15**
5	Competitive Review: Quantitative Aptitude, Quantitative Ability (Basic Mathematics) Number Systems - LCM and HCF, Decimal Fractions, Simplification Square Roots and Cube Roots – Average, Problems on Ages, Surds & Indices, Percentages Problems on Numbers.	**15**

	Prescribed Text
1	Kappor, V.K., Business Mathematics, Sultan Chand & Sons, New Delhi
	Books for Reference
1	Agarwal, B.M., Basic Mathematics & Statistics, Sultan Chand & Sons, New Delhi
2	Rajagopalan, S. & Sattanathan., R., Business mathematics, McGraw-Hill, New Delhi
3	Bari, Business Mathematics, New Literature Publishing Company, Mumbai.
4	Bhardwaj, R. S. (2019). Business Mathematics and Statistics. New Delhi: Scholar Tech Press
5	Thukral, J. K. (2017). Business Mathematics and Statistics. New Delhi: Maximax Publications.
6	Vohra, N. D. (2014). Business Mathematics and Statistics. New Delhi: Tata McGraw Hill Education India.

Title of the course	BUSINESS STATISTICS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester	Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem-solving skills				

Course Outcomes

CO1	Understand and apply the principles of statistics, including data collection, classification, and presentation methods.
CO2	Analyze univariate data using measures of central tendency, dispersion, and skewness.
CO3	Apply correlation and regression analysis techniques to bi-variate data for understanding relationships between variables.
CO4	Construct and analyze index numbers, including price indices and various methods for calculation.
CO5	Analyze time series data by identifying trends, seasonal variations, and applying appropriate methods for trend estimation.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Statistics: Definition-Functions, Scope, and Limitations of statistics - Statistical Enquiry Stages in conducting a statistical survey-Primary data Vs secondary data-Sources of secondary data - Classification, Tabulation and Presentation of data- Diagrams	15
2	Univariate Analysis: (a) Measures of Central Tendency: Average – Meaning - Characteristics of a typical average - Computation of Mean, Median, Mode, Geometric Mean, Harmonic Mean, and Weighted Arithmetic Mean- Merits and Limitations of each.(b) Measures of Dispersion: Dispersion - Meaning - Properties of a good measure of dispersion - Absolute versus relative measure of dispersion - Computation of Range, Quartile Deviation, Mean Deviation, Standard Deviation and Co-efficient of Variation- Merits and Limitations of each.(c) Skewness: Meaning - Variation versus Skewness - Measures of Skewness- Karl and Co-efficient of Skewness.	15
3	Bi-variate Analysis: (a) Simple and Liner Correlation Analysis: Meaning – Definition - Types of Correlation Methods of Studying Correlation - Correlation) and Properties. (b) Simple and Liner Regression Analysis: Definition – Correlation Vs Regression Regression lines and Regression Equations Regression co-efficient- Computation of correlation co-efficient from regression co-efficient.	15
4	Index Numbers: Definition - Characteristics of Index numbers – Uses - Types of index numbers - Construction of Price Index numbers - Unweighted Index numbers -Weighted Index numbers - Tests	15

	of adequacy of Index number - formulae. Chain - basis index number base shifting, splicing, and deflating problems in constructing index numbers; Consumer price index	
5	Analysis of Time Series: Introduction Uses - Components of time series - Measurement of trend-graphical method, semi-average method, moving average and method of least square (including linear, second degree, Parabolic and exponential trend) - Computational of seasonal, indices by simple average, Ratio - trend, ratio - to - moving average and link relative methods.	**15**

	Prescribed Text
1	J. K. Sharma, Business Statistics, Vikas Publishing House (P), Ltd., New Delhi.
2	R.S.N. Pillai and Bagavathi, Business Statistics, S. Chand & Co., New Delhi
	Books for Reference
1	S.P. Gupta & M.P Gupta, Statistical Methods, Sultan Chand & Co, New Delhi
2	K. Alagar, Business Statistics, Tata McGraw Hill Publications, New Delhi
3	Arora & Arora., Statistics for Management, S.Chand & Co, New Delhi

Title of the course	NUMERICAL ANALYSIS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Pre requisites if any	Basic understanding of algebra, calculus, and problem-solving techniques.				

Course Outcomes

CO1	Solve algebraic and transcendental equations using various numerical methods such as Bisection, Successive Approximation, Regula Falsi, and Newton-Raphson.
CO2	Solve simultaneous linear algebraic equations using numerical techniques like Gauss Elimination, Gauss Jordan, and Gauss Seidel methods.
CO3	Perform interpolation and numerical differentiation/integration using methods like Newton-Gregory, Lagrange, and Simpson's rules.
CO4	Apply numerical methods to solve ordinary differential equations of first and second order using techniques like Taylor series, Picard's method, and others.
CO5	Implement advanced methods for solving ordinary differential equations, including Euler's method, Runge-Kutta method, and Milne's predictor-corrector method.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.	15
2	Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.	15
3	Finite difference operator - Interpolation – Newton-Gregory forward and backward interpolation – Newton's divided difference formula – Lagrange's interpolation formula for uneven intervals – Gauss interpolation formula – Numerical differentiation – Numerical Integration – Trapezoidal rule – Simpson's 1/3rd rule.	15
4	Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.	15
5	Euler's method – Improved Euler's Method - Modified Euler's Method – Runge- Kutta method of second and fourth order – Milne's predictor corrector method.	15

Prescribed Text

1	Numerical Method in Science and Engineering, M.K. Venkataraman, National Publication Co, Chennai(2001) Unit 1: Chapter 3 and 4 , Unit 2: Chapter 5 , Unit 3 : Chapter 6 and 9, Unit 4:Chapter11(Relevant portions), Unit 5:Chapter11(Relevant portions)

Books for Reference

1	Computer oriented Numerical Methods by V.Rajaram–PHI(P)Ltd. e-Learning Source

Title of the course	OPTIMIZATION TECHNIQUES – I	Nature of the Course	Minor	Subject Code	

Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic knowledge of algebra, optimization methods, and problem-solving techniques in mathematical contexts.

Course Outcomes

CO1	Understand the origins, development, and features of Operations Research (O.R.), and apply Linear Programming methods to production allocation, product mix, and allocation problems using graphical solutions and mathematical formulations.
CO2	Solve Linear Programming Problems using the Simplex Method, Artificial variables, Two-Phase method, and Big-M method for optimization.
CO3	Formulate and solve Transportation Problems using methods like the Modi method, addressing issues such as optimality and degeneracy in transportation.
CO4	Solve Assignment Problems, including maximizing assignments, using appropriate solution methods and handling special cases in assignments.
CO5	Use PERT/CPM for network scheduling, apply critical path analysis, and understand network construction rules for concurrent activities.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Operations Research–An overview: Introduction – Origin and development of O.R.–Nature and features of O.R. – Applications of Operations Research programming problem: Mathematical formulation-production allocation problem, product mix problem, product allocation problem only- Graphical solution method - General LPP - Canonical and Standard forms only.	15
2	Linear programming problem- Simplex Method: Introduction – The computational procedure –The Simplex Algorithm – Use of Artificial variables -Two-Phase method – Big-M method.	15
3	Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - Modi method.	15
4	Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.	15
5	Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.	15

Prescribed Text

1	"Operations Research" by Kanti Swarup, P.K.Gupta and Man Mohan, Sultan Chand & Sons Educational Publishers, New Delhi, 16th Edition 2014. Unit I : Chapter 1, 2 & 3 Sections 1.1 to 1.3, 1.10, 2.1 to 2.4, 3.2 to 3.5 Unit II : Chapter 4 Sections 4.1, 4.3, 4.4 , Unit III : Chapter 10 Sections 10.1, 10.2, 10.5, 10.8, 10.9, 10.10, 10.12, 10.13, Unit IV : Chapter 11 Sections 11.1 to 11.4, Unit V : Chapter 25 Sections 25.1 to 25.6

Books for Reference

1	Hamdy A., Taha, Operations Research, Pearson publisher, 9 th Edition,2012

Title of the course	OPTIMIZATION TECHNIQUES – II	Nature of the Course	Minor	Subject Code	

Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75

Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs

Course Prerequisites if any	Basic mathematical and problem solving skills

Course Outcomes

CO1	Understand the basic concepts and terminology related to sequencing problems and apply them to solve job sequencing problems with multiple machines.
CO2	Analyze and solve two-person zero-sum games, including games with saddle points, mixed strategies, and graphical solutions for various game matrix forms.
CO3	Evaluate and apply different replacement policies in various contexts, including when the value of money changes or when equipment fails suddenly.
CO4	Apply inventory control models to solve real-world problems, focusing on the Economic Order Quantity (EOQ) model and handling price breaks and shortages.
CO5	Analyze queueing systems using various models, understand the classification of queueing models, and apply the Poisson queueing systems for different practical scenarios.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Sequencing Problem: Introduction –Problem of sequencing – Basic terms used in sequencing –Processing n jobs through two machines – Processing n jobs through k machines.	15
2	Games and Strategies : Two person zero sum games - Some basic terms - the maximin - minimax principle - Games without saddle points - Mixed strategies - graphic solution of 2 x n and m x 2 games – Dominance property .	15
3	Replacement Problems : Introduction – Replacement policy when value of money does not change with time – Replacement policy when value of money changes with time – Replacement of equipment that fails suddenly - Group replacement policy .	15
4	Inventory Control : Costs associated with inventories – Factors affecting inventory control - An inventory control problem – The concept of EOQ – Deterministic inventory with no shortages – Deterministic inventory problem with shortages – problems of EOQ with price breaks.	15
5	Queueing Theory – Elements of a queueing system – Classification of queueing models – Definition of transient and steady states – Poisson Queueing Systems – Model I { (M/M/1):(∞/FIFO)} – Model III {(M/M/1) : (N/FIFO)} – Model V {(M/M/C):(∞/$FIFO$)}.	15

Prescribed Text

1	Kanti Swarup, P.K. Gupta and Man Mohan, Operations Research, 16th edition, Sultan Chand and Sons, Reprint 2014. Unit I : Chapter 12- sec 12.1 to 12.5 pp.327 – 338 Unit II : Chapter 17- sec 17.1 to 17.7 pp.443 – 464 , Unit III : Chapter 18 – sec 18:1, 18:2.1,18:2.2,18:3 pp.478 – 492, Unit IV : Chapter 19 – sec 19.6 to 19.12 pp. 510 – 538, Unit V : Chapter 21 – sec 21:3, 21:7, 21:8, 21:9, pp.589,590,596 to 604, 608 to 610, 613to 618

Books for Reference	
1	Resource Management Techniques(Operations Research) by V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan – A. R. Publications
2	Operations Research: An Introduction, 9th edition, Hamdy A.Taha, Pearson, 2010

Title of the course	APPLIED STATISTICS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem solving skills				

Course Outcomes

CO1	Understand and apply different types of diagrammatic and graphic presentations to represent data.
CO2	Calculate and interpret various measures of central tendency such as mean, median, and mode in both discrete and continuous data.
CO3	Understand and compute measures of dispersion, including range, interquartile range, mean deviation, and standard deviation, and apply them in real-life data analysis.
CO4	Analyze the relationship between two variables through correlation analysis, using Pearson's and rank correlation methods.
CO5	Apply regression analysis to predict and understand the relationship between variables using regression lines and equations.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Diagrammatic and Graphic Presentation: General Rules for Constructing Diagrams, Types of Diagrams, One Dimensional or Bar Diagrams, Types of Bar Diagrams, Two-Dimensional Diagrams Limitations of Pie Diagrams.	15
2	Measures of Central Value: Arithmetic Mean: Calculation of Simple Arithmetic Mean Individual Observations, Calculation of Arithmetic Mean-Discrete Series, Calculation of Arithmetic Mean Continuous Series, Merits and Limitations of Arithmetic Mean. Median: Calculation of Median-Individual Observations, Computation of Median-Discrete Series, Calculation of Median-Continuous Series, Merits and Limitations of Median Mode: Calculation of Mode-Individual Observations, Calculation of Mode-Discrete Series, Calculation of Mode-Continuous Series, Merits and Limitations of Mode.	15
3	Measures of Dispersion: Significance of Measuring Variation, Properties of a Good Measure of Variation, The Interquartile Range or the Quartile Deviation, Merits and Limitations, The Mean Deviation, Calculation of Mean Deviation, Calculation of Mean Deviation – Continuous Series, Merits and Limitations, The Standard Deviation, Difference Between Mean Deviation and Standard Deviation, Calculation of Standard Deviation, Merits and Limitations.	15

4	Correlation Analysis: Types of Correlation, Scatter Diagram Method, Merits and Limitations of the Method, Karl Pearson's Coefficient of Correlation, Direct Method of Finding Out Correlation Coefficient, Origin is made and Problems, Rank Correlation Coefficient, Merits and Limitations of the Rank Method.	**15**
5	Regression Analysis: Uses of Regression Analysis, Difference Between Correlation and Regression Analysis, Regression Lines, Regression Equations, Regression Equation of Y on X, Regression Equation of X on Y and Problems	**15**

	Prescribed Text
1	S.P.GUPTA, "Statistical Methods", Sultan Chand &Sons, Educational Publishers, New Delhi,2016
	Books for Reference
1	P.R.Vittal, "Mathematical Statistics", Margham Publications, 2016

LIST OF MINOR COURSES-STREAM III

Physics, Chemistry, other science courses (Other than Mathematics)

Title of the course	MATRICES AND TRIGONOMETRY	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem-solving skills				

Course Outcomes

CO1	Understand and apply the concept of rank of matrices and consistency of systems of linear equations.
CO2	Learn the evaluation of eigenvalues and eigenvectors of square matrices and the application of the Cayley-Hamilton theorem.
CO3	Gain proficiency in the application of De Moivre's theorem and circular and hyperbolic functions.
CO4	Acquire skills in calculating logarithms of complex quantities and expanding trigonometric functions.
CO5	Learn methods for the summation of the series, including Gregory's series.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Matrices – rank of Matrices – Consistency of a system of linear non – homogeneous equations (statement only) – simple problems	15
2	Characteristic roots of a square matrix – Evaluation of Eigen values and Eigen vectors of a vectors of a square matrix – Cayley Hamilton theorem (statement only) – simple problems – Orthogonal transformation of a symmetric matrix to diagonal form	15
3	De Moivre's theorem and its applications – Direct and Inverse circular and hyperbolic functions.	15
4	Logarithm of a complex quantity- Expansion of Trigonometrical functions	15
5	Gregory's series- Summation of series	15

Prescribed Text

1	Dr. P.R. Vittal, Allied Mathematics, Margham Publications, 2018
2	Trigonometry, S. Narayanan and T.K. Manicavachagom Pillai, S. Viswanathan (Printers & Publishers) Pvt. Ltd, (1997)

Books for Reference

1	John Bird, Bird's Higher Engineering Mathematics, (9e), Routledge, Taylor & Francis Group, 2021

Title of the course	CALCULUS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem solving skills				

Course Outcomes

CO1	Apply nth derivative, standard results, trigonometric transformation, and Leibnitz formula.
CO2	Understand and use total differential coefficients, Euler's theorem, and partial derivatives for functions of two variables.
CO3	Apply methods for finding maxima and minima using Lagrange's method of undetermined multipliers.
CO4	Calculate the radius and center of curvature, and use Cartesian formula for radius of curvature and envelope.
CO5	Integrate rational and irrational algebraic functions, apply properties of definite integrals, and evaluate double and triple integrals.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	n^{th} derivative – Standard results – Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula	15
2	Total differential coefficients – Euler's theorem – Partial derivatives of a function of two functions -Maxima and Minima of two variables – Lagrange's method of undetermined multipliers	15
3	Circle, radius, and center of curvature – Cartesian formula for the radius of curvature – envelope	15
4	Integration of rational algebraic functions – Integration of irrational algebraic functions - Properties of definite integrals	15
5	Integration by parts – reduction formula, Bernoulli's formula - Evaluation of double integral (Cartesian form only) – Triple integral (Cartesian form only)	15

Prescribed Text

1	Calculus Volume — I, T. K. Manickavachagom Pillai, Printers and Publishers (May1992 Edition) Unit 1: Chapter 3 – 1.1, 1.2, 1.3, 1.4,1.5, 1.6, 2.1, Unit 2: Chapter 8-1.3, 1.4, 1.5, 1.6, 1.7, 4, 4.1, 5, Unit 3: Chapter 10 – 1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5
2	Calculus Volume II , S.Narayanan and T.K. Manickavasagam Pillai (2008) Unit 4 : Chapter 1 : 7.3, 7.4, 7.5, 8, 11, Unit 5 : Chapter 1: 12,13,14, 15.1, and Chapter 5: 2, 4,

Books for Reference

1	Integral Calculus, N. P. Bali, Laxmi Publications, Delhi, (1991)
2	Calculus(2nd Edition), Lipman Bers and Frank Karal, Holt McDougal, 1976
3	Thomas' Calculus 12th Edition, George B.Thomas, Maurice D.Weir and Joel Hass, Pearson Education, 2015

Title of the course	VECTOR CALCULUS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem solving skills				

Course Outcomes

CO1	To attain the basic knowledge on vector calculus.
CO2	Understand and apply vector differentiation, including the gradient and its physical applications.
CO3	Gain an understanding of divergence and curl, and their applications in vector calculus.
CO4	Learn vector integration techniques such as line, surface, and volume integrals.
CO5	Understand and apply Gauss divergence theorem, Green's theorem, and Stoke's theorem with simple problems.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Vector differentiation – Differentiation of vectors – Meaning of the derivative of position vector – Physical applications -– Vector differential operator - Gradient - Direction and magnitude of gradient – Simple problems	15
2	Divergence and curl - Formula involving operator, operators involving twice – Simple problems.	15
3	Vector integration - Line integral – Surface integral – Volume integral – Simple problems	15
4	Gauss divergence theorem – Green's theorem (in space) (Statement only) – Simple problems using theorems.	15
5	Stoke's theorem - Green's theorem (in plane) (Statement only) – Simple problems using theorems.	15

Prescribed Text

1	S. Narayanan and T.K. Manicavachagom Pillai, Vector Algebra and Analysis, S.Viswanathan Pvt. Ltd. (1995). UNIT I Chapter 4 Sections 1 – 8, UNIT II Chapter 4 Sections 9 – 12, UNIT III Chapter 6 Sections 1 – 5, UNIT IV Chapter 6 Sections 6 – 8, UNIT V Chapter 6 Sections 9, 10

Books for Reference

1	M.L. Khanna, Vector Calculus, Jai Prakash Nath and Co., Eighth Edition (1986).
2	P.R. Vittal, Vector analysis, Analytical Geometry & sequences and series, Margham Publications, Chennai (2004).

Title of the course	INTRODUCTION TO DIFFERENTIAL EQUATIONS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem solving skills				

Course Outcomes

CO1	Understand and solve ordinary differential equations and their applications, including orthogonal trajectories.
CO2	Solve linear differential equations with constant coefficients and simultaneous differential equations.
CO3	Form partial differential equations and solve them using Lagrange's methods.
CO4	Analyze and solve linear partial differential equations of second and higher order with constant coefficients using the Charpits method.
CO5	Apply boundary value problems to transverse vibrations and one-dimensional heat flow problems.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Ordinary differential equations – linear equations and equations reducible to the linear form - Exact differential equations – Equations of the First, but of higher degree – Equations solvable for dy/dx, solvable for y, solvable for x, Clairaut's form and singular solutions – geometrical meaning of differential equations – orthogonal trajectories.	15
2	Linear Differential equations with constant coefficients – Homogenous linear ordinary differential equation – linear differential simultaneous differential equations.	15
3	Formation of Partial differential equations – by elimination of arbitrary constants – by elimination of arbitrary functions – Defines of general, particular, and complete solutions - Singular integral – Lagrange's method of solving the linear equation Pp+Qq=R	15
4	Charpits method - Linear Partial Differential equation of second and higher order with constant coefficients.	15
5	Boundary value problems method of separation of variable transverse vibrations of string – the one-dimensional heat flow equations a Cartesian form.	15

Prescribed Text

1	T.K. Manicavachagom Pillay , Calculus , Volume – I, S. Viswanathan (Printers and Publishers) Pvt Ltd. (2004)
2	Dr. M.B.K. Moorthy & K. Senthilvadivu, Transforms and partial differential equations VRB Publishers, (2009).
3	Transforms and Partial differential equations by Dr. A. Singaravelu

Books for Reference

1	Introductory course in Differential equations , D.A.Murray, Orient Longman (1967)
2	Engineering Mathematics , M.K.Venkataraman, National Publications , Chennai (2009) e-Learning Source

Title of the course	FOURIER SERIES AND LAPLACE TRANSFORMS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Prerequisites if any	Basic mathematical and problem-solving skills				

Course Outcomes

CO1	Understand and analyze the conditions for Fourier series expansions, including odd and even functions and half-range expansions.
CO2	Apply the complex form of the Fourier series and Parseval's identity for solving mathematical problems.
CO3	Solve simultaneous differential equations and transform equations using methods like the variation of parameters.
CO4	Comprehend and utilize the Laplace transform, its properties, and shifting theorems for solving problems involving standard forms.
CO5	Solve ordinary differential equations with constant coefficients using Laplace transforms.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Dirichlet's condition general Fourier series Odd and Even Functions half range Sine series and Half range cosine series.	15
2	Complex form of Fourier series Parseval's Identity.	15
3	Transform of the equation by changing the dependent variables / the independent variables – Method of variations of parameters – ordinary simultaneous differential equations.	15
4	Definition transform of 1 – transform of the function e^{-at} , $\cos at$, $\sin bt$, t^n , where n is a positive integer, $\sinh at$, $\cosh at$ - first shifting theorem – if the Laplace transform of a function f(t) is $\emptyset(s)$, then the Laplace transform of $e^{-at} f(t)$ is $\emptyset(s + a)$ - Laplace transform of $e^{-at} \cos bt$, $e^{-at} \sin bt$, $e^{-at} t^n$ - Second shifting theorem – Transform of $f'(t)$ and $f''(t)$ – inverse transform relating to the above standard forms.	15
5	Application to solution of ordinary differential equation with constant coefficients – involving the above transforms.	15

Prescribed Text

1. Dr. M.B.K. Moorthy & K. Senthilvadivu, Transforms and partial differential equations VRB Publishers, (2009).
2. T.K. Manicavachagom Pillay , Calculus , Volume – I, S. Viswanathan (Printers and Publishers) Pvt Ltd. (2004)

Books for Reference

1. Introductory course in Differential equations , D.A.Murray, Orient Longman (1967)
2. Engineering Mathematics , M.K.Venkataraman, National Publications , Chennai (2009)

Title of the course	NUMERICAL ANALYSIS	Nature of the Course	Minor	Subject Code	
Credits	4	Semester		Type of course	Theory	No. of Hours of Teaching	75
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs
Course Pre requisites if any	Basic mathematical and problem solving skills				

Course Outcomes

CO1	Understand and apply numerical methods for solving algebraic and transcendental equations using methods like bisection, successive approximation, Regula Falsi, and Newton-Raphson.
CO2	Solve systems of simultaneous linear algebraic equations using methods such as Gauss elimination, Gauss Jordan, and Gauss-Seidel iteration.
CO3	Comprehend and use finite difference operators, interpolation techniques (Newton-Gregory, Lagrange, and Gauss), and methods for numerical differentiation and integration like the Trapezoidal and Simpson's 1/3rd rule.
CO4	Analyze and solve ordinary differential equations using numerical techniques like Taylor series and Picard's method.
CO5	Implement advanced numerical methods like Euler's, Improved Euler's, Modified Euler's, Runge-Kutta (second and fourth order), and Milne's predictor-corrector method for solving differential equations.

Unit No	Course Content	No. of Hours
	Theory Component (75 Hours)	
1	Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.	15
2	Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.	15
3	Finite difference operator - Interpolation – Newton-Gregory forward and backward interpolation – Newton's divided difference formula – Lagrange's interpolation formula for uneven intervals – Gauss interpolation formula – Numerical differentiation – Numerical Integration – Trapezoidal rule – Simpson's 1/3rd rule.	15
4	Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.	15
5	Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.	15

Prescribed Text

1	Numerical Method in Science and Engineering, M.K. Venkataraman, National Publication Co, Chennai (2001). Unit 1: Chapter 3 and 4, Unit 2: Chapter 5, Unit 3: Chapter 6 and 9, Unit4: Chapter11 (Relevant portions), Unit 5:Chapter11(Relevant portions)

Books for Reference

1	Computer oriented Numerical Methods by V.Rajaram–PHI(P)Ltd. e-Learning Source

LIST OF SKILL ENHANCEMENT COURSES (SEC)

Title of the course	PYTHON PROGRAMMING (Practical)	Nature of the Course	SEC 1	Subject Code	MTDSSE01

Credits	3	Semester	1	Type of course	Practical	No. of Hours of Teaching	60

Internal Assessment Marks (IA)	50	End Semester Examination (ESA)	50	Duration of ESA	3 hrs

Course Prerequisites if any	Basic problem-solving skills

Course Outcomes

CO1	Understand the basics of writing Python code
CO2	Implement programs using lists, tuples, and dictionaries
CO3	Understand the use of control structures
CO4	Ability to write programs using packages
CO5	Understand file manipulation

Unit No	Course Content	No. of Hours
	Theory Component (30 Hours)	
1	**Introduction to Python:** The Python programming language Python, debugging, Formal and natural languages, Values and types, Variables, Variable names and keywords, Statements, Evaluating expressions, Operators and operands, Order of operations, Operations on strings, Composition, Comments, Function calls, Type conversion, Type coercion, Math functions, Composition, Adding new functions, Definitions and use, Flow of execution, Parameters and arguments, Variables and parameters are local, Stack diagrams, Functions with results.	6
2	**Conditionals and recursion:** The modulus operator, Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, The return statement, Recursion, Stack diagrams for recursive functions, Infinite recursion, Keyboard input, Fruitful functions, Return values, Program development, Composition, Boolean functions, More recursion, Leap of faith, Checking types.	6

3	**Iteration and Strings:** Multiple assignments, The while statement, Tables, Two-dimensional tables, Encapsulation and generalization, More encapsulation, Local variables, More generalization, Strings: A compound data type, Length, Traversal and the for loop, String slices, String comparison, Strings are immutable, A find function, Looping and counting, The string module, Character classification.	6
4	**Lists and Tuples:** List values, Accessing elements, List length, List membership, Lists and for loops, List operations, List slices, Lists are mutable, List deletion, Objects and values, Aliasing, Cloning lists, List parameters, Nested lists Matrices, Strings, and lists, Tuples: Mutability and tuples, Tuple assignment, Tuples as return values, Random numbers, List of random numbers, Counting, Many buckets, A single-pass solution, Dictionaries: Dictionary operations, Dictionary methods, Aliasing and copying, Sparse matrices, Hints, Long integers, Counting letters.	6
5	**Files and exceptions:** Text files, Writing variables, Pickling, Exceptions Classes and objects: User-defined compound types, Attributes, Instances as arguments, Sameness, Rectangles, Instances as return values, Objects are mutable, Copying, Classes and functions Time, Pure functions, Prototype development versus planning, Classes and methods: Object-oriented features, Print Time, A more complicated example, Optional arguments, The initialization method, Points revisited, Operator overloading, Polymorphism.	6

Exercise No	Practical Component - **Internal Assessment marks (IA)-50**	No. of Hours
1	Exchange the values of two variables	30
2	Finding minimum among n variables	
3	Perform Simple sorting	
4	Generate the Student's marks statement	
5	Find the square root, GCD, exponentiation	
6	Sum the array of numbers	
7	Perform linear search, binary search	
8	Perform Matrix operations using NumPy	
9	Perform Dataframe operations using Pandas	
10	Use Matplotlib on the dataset and visualize	

Text Books

1	Allen Downey, Jeffrey Elkner, Chris Meyers How to Think Like a Computer Scientist, Learning with Python, Green Tea Press, 2002

2	Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
	Books for Reference
1	Mark Lutz, Learning Python , O'Reilly, 5th Edition, 2013.
2	Daniel Liang, Introduction to Programming using Python , Pearson, 1st Edition, 2021.
3	Wes Mc Kinney, Python for Data Analysis , O'Reilly Media, 2012.
4	Tim Hall and J-P Stacey, Python 3 for Absolute Beginners , Apress, 1st Edition, 2009.
5	Magnus Lie Hetland, Beginning Python: From Novice to Professional , Apress, 2nd Edition, 2005.

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	R – PROGRAMMING (Practical)	Nature of the Course	SEC 2	Subject Code	MTDSSE02
Credits	3	Semester	2	Type of course	Practical	No. of Hours of Teaching	60
Internal Assessment Marks (IA)	50	End Semester Examination (ESA)	50	Duration of ESA	3 hrs
Course Prerequisites if any	Basic problem-solving skills				

Course Outcomes

CO1	Demonstrate proficiency in R programming basics, including installation, opening, saving, and editing R code.
CO2	Perform basic math operations, assign objects, and manipulate vectors in R.
CO3	Analyze and manipulate matrices and arrays.
CO4	Create and manipulate lists and data frames.
CO5	Read and write files in R, handling R-ready datasets and external data files.

Unit No	Course Content	No. of Hours
	Theory Component (30 Hours)	
1	Introduction: R Installation – opening – Saving and Editing – Conventions Number, Arithmetic, assignment & Vectors R for Basic Math – Assigning Objects – Vectors.	6
2	Matrices and Arrays: Defining a Matrix – Sub setting – Matrix Operations & Algebra – Multidimensional Arrays.	6
3	Non-numeric Values: Logical Values – Characters - Factors Lists and Data Frames: Objects – Data Frames.	6
4	Special Values, Classes, and Coercion Some special values – Understanding Types, classes, and Coercion Basic Plotting Using Plot with coordinate Vectors – Graphical Parameters – Adding Plots, lines, and Text – ggplot2.	6
5	Reading and Writing Files, R-Ready Data sets – Reading in External data files – Writing out Data files and Plots – Adhoc Object R/W.	6

Exercise No	Practical Component - Internal Assessment marks (IA)-50	No. of Hours
1	Practice Installing, opening, and saving files in R.	30
2	Create and store a vector that contains A sequence of integers. A threefold repetition of a real value Numbers divisible by 2.	
3	Create a matrix and find the number of entries in each row that are greater than ‘n’	

4	Write a program to Add and multiply two matrices	
5	Write a program to transpose and find the inverse of a matrix.	
6	Store a vector with 15 values as an object. Identify those equal to 6, those greater than or equal to 6, those less than 6 + 2, those not equal to 6	
7	With the Weight (kg), height (cm), and Sex data of 10 students, create a plot of weight on the x-axis and height on the y-axis. Use different point characters or colors to distinguish between males and females and provide a matching legend. Label the axes and give the plot a title.	
8	Demonstrate Visualization using ggplot2	

Prescribed Text

1	Tilman M.Davies, The Book of R: A First Course in Programming and Statistics , No Starch press, 2016.

Books for Reference

2	Bradley C. Boehmke, Data wrangling with R , Springer, 2016.
3	Andrea de Vries, Joris Meys, R programming for Dummies , 2nd Edition, Wiley, 2016.

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

Title of the course	LATEX (Practical)	Nature of the Course	SEC 3	Subject Code	MTDSSE03

Credits	3	Semester	3	Type of course	Practical	No. of Hours of Teaching	60

Internal Assessment Marks (IA)	50	End Semester Examination (ESA)	50	Duration of ESA	3 hrs

Course Prerequisites if any	Nil

Course Outcomes

CO1	Create basic LaTeX documents with appropriate formatting and structure as demonstrated in" Learning LaTeX."
CO2	Proficiently typeset mathematical equations and expressions using LaTeX, following the examples and techniques presented in the book.
CO3	Format and style LaTeX documents according to academic standards, drawing from the knowledge provided in "Learning LaTeX."
CO4	Apply advanced LaTeX features, as covered in the book, to create complex mathematical documents and presentations.
CO5	Use LaTeX for research, publications, and collaborative projects in mathematics, applying the principles and practices outlined in the book.

Unit No	Course Content	No. of Hours
	Theory Component (30 Hours)	
1	Introduction to LaTeX: Motivation for Learning LaTeX, Running LaTeX, Resources for LaTeX	6
2	Basic LaTeX: Sample Document and Key Concepts, Type Style in LaTeX, LaTeX Environments: Lists, Centering, Tables, Verbatim, Managing Vertical and Horizontal Spacing	6
3	Typesetting Mathematics: Examples of Mathematical Typesetting, Equation Environments in LaTeX, Fonts, Hats, and Underlining in Mathematical Notation, Using Braces, Arrays, and Matrices, Creating Customized Commands, Theorem-like Environments in LaTeX, Miscellaneous Mathematical Notation and Styles	6
4	Further Essential LaTeX: Document Classes and Document Structure, Titles for LaTeX Documents, Sectioning Commands, Miscellaneous Extras: Spacing, Accented Characters, Dashes, Hyphens, Quotation Marks, Troubleshooting LaTeX: Error Identification and Common Errors	6
5	More About LaTeX: Introduction to LaTeX Packages, Inputting External Files, Inserting Pictures and Graphics, Creating Bibliographies, Generating an Index, Exploring the History of LaTeX, Exploring Online LaTeX Resources and Professional Societies.	6

Exercise No	Practical Component - Internal Assessment marks (IA)-50	No. of Hours
1	Introduction to LaTeX Task: Create a basic LaTeX document with a title, author, date, and a simple paragraph. Objective: Familiarize students with the LaTeX environment and basic commands	30
2	Formatting Text	

	Task: Create a document with different text styles (bold, italics, underline), lists (itemized, enumerated), and tables. Objective: Learn how to structure text and create lists and tables in LaTeX.	
3	Mathematical Typesetting Task: Typeset various mathematical expressions and equations using different equation environments. Objective: Gain proficiency in mathematical typesetting, including using subscripts, superscripts, and special characters.	
4	Advanced Mathematical Notation Task: Create a document with arrays, matrices, and customized commands for complex mathematical expressions. Objective: Understand advanced mathematical typesetting and customization of commands.	
5	Theorem-Like Environments Task: Create a document with theorem-like environments for definitions, theorems, proofs, and examples. Objective: Learn to structure mathematical documents with proper logical sections.	
6	Document Structure and Sectioning Task: Create a well-structured document using different sectioning commands (e.g., sections, subsections, subsubsections) with a table of contents. Objective: Master the document structure and organization in LaTeX.	
7	Inserting Figures and Tables Task: Insert external images, create tables with captions, and adjust figure and table positions within the text. Objective: Learn how to include and format figures and tables within LaTeX documents.	
8	Bibliography Management Task: Create a bibliography section using BibTeX or LaTeX's built-in bibliography commands. Objective: Learn how to manage references and citations in academic documents.	
9	Creating Presentations with Beamer Task: Create a simple presentation using the Beamer package, including slides with text, images, and bullet points. Objective: Introduce students to LaTeX-based presentations.	
10	Final Project Task: Create a comprehensive document or presentation incorporating all the learned skills, with a focus on research or academic content. Objective: Apply all the skills acquired throughout the course in a single cohesive project.	

Prescribed Text	
1	"Learning LaTeX" by David F. Griffiths and Desmond J. Higham
Books for Reference	
2	The LaTeX Companion, 3rd edition (TTCT series) by Frank Mittelbach and Ulrike Fische

*The Course Instructor can customize the practical exercises and the number of exercises in the Practical Component

MULTIDISCIPLINARY COURSE (MLDC)

Offered by the Department of Mathematics

Title of the course		BASIC MATHEMATICS		Nature of the Course	MLDC		
Credits	3	Semester	II	Type of course	Theory	No. of Hours of Teaching	60
Internal Assessment Marks (IA)	25	End Semester Examination (ESE)	75	Duration of ESE	3 hrs		
Course Prerequisites, if any	Basic mathematical and problem-solving skills						

Course Outcomes	
CO1	Analyze linear systems and matrix transformations.
CO2	Solve linear systems using various matrix forms and polynomial interpolation.
CO3	Apply logic and set theory operations to solve problems.
CO4	Use inclusion-exclusion, addition/multiplication rules, and pigeonhole principles in problem solving
CO5	Calculate permutations, combinations, and apply elementary probability to problems.

Unit No	Course Content	No. of Hours
	Theory Component (60 Hours)	
1	Linear System – Matrices – dot Product – Matrix multiplication – properties of Matrix operations –Matrix transformation	12
2	Solution of linear system of equations – row echelon form – reduced row echelon form – Polynomial interpolation – inverse of a matrix – linear systems	12
3	Logic – truth table – algebra of propositions- logical arguments – sets-operations on sets.	12
4	Principle of inclusion-exclusion – the addition and multiplication rules – pigeonhole principles.	12
5	Permutations – Combinations – Elementary Probability.	12

Prescribed Text

1. Bernard Kolman, Dred. R. Hill, Introductory Linear Algebra, 8th edition – pearson, India 2011.
2. Edgar G. Goodaire, Michael. M. Parmenter, Discrete Mathematics with Graph Theory, 3ePHI, India, 2011.

Title of the course	COMMUNITY ENGAGEMENT AND SERVICE	Nature of the Course	Value added Course (VAC)	Subject Code	MTDSCE01

Credits	2	Semester	IV	Type of course	Practical	No. of days	15

Internal Assessment Marks (IA)	50	End Semester Examination (ESE)	50

Course Prerequisites, if any	NIL

Community Engagement

The Community Engagement Learning Project is a short course that offers students the chance to collaborate with a nonprofit or government organization through a group project chosen by the organization. Students will investigate the concept of community engagement, examine the role of the community sector in their local area, and analyze the operational context and tools the sector uses to deliver services, influence policies and programs, and share information with its clients. Additionally, the seminar program and hands-on collaboration with a local organization will enable students to develop a diverse range of skills.

Course Guidelines

- The Community Engagement course is typically offered during the fourth semester.
- The course is evaluated out of a maximum of 100 marks, with assessments based on a report, presentation, and viva voce.
- Students may complete the course as a group, however, each team member must submit an individual report.
- A faculty member, designated by the Head of the Department, will supervise the course.
- An internal examiner will oversee the course evaluation.
- The course is designed to encourage student interaction with the end users.
- The chosen project should provide sufficient scope to apply and demonstrate the concepts learned during the course.
- Internal marks (based on Internship report, work dairy, etc.): 50 marks.
- External marks (based on presentation, viva voce, etc.): 50 marks

Title of the course	SUMMER INTERNSHIP FOR 45 DAYS	Nature of the Course	Skill Enhancement Course (SEC)	Subject Code	MTDSSI01

Credits	4	Semester	V	Type of course	Practical	No. of days	45

Internal Assessment Marks (IA)	50	End Semester Examination (ESE)	50

Course Prerequisites if any	NIL

Summer Internship

A summer internship is a short-term work placement, usually during the summer break, where students gain hands-on experience in their field. It allows them to apply classroom theories in a real-world environment, develop both technical and soft skills, and build professional networks. Interns work on projects that expose them to industry practices and workplace dynamics, providing valuable insights into their future careers.

Course Guidelines:

- The Summer Internship course is typically offered during the fifth semester.
- The course is evaluated out of a total of 100 marks, with assessments based on a report, presentation, and viva voce.
- Students may work in groups; however, each member must submit an individual report.
- A faculty member, designated by the Head of the Department, will supervise the course.
- An internal examiner will be responsible for evaluating the course.
- The course is designed to encourage meaningful interaction with the end user.
- The selected internship project should provide ample opportunities to apply and demonstrate the concepts learned in the course.
- Internal marks (based on Internship report, work dairy, etc.): 50 marks.
- External marks (based on presentation, viva voce, etc.): 50 marks