Department of Mathematics

(AFFILIATED COLLEGES)

PONDICHERRY UNIVERSITY

UG Degree (BS Honours) with Research in Mathematics

NATIONAL EDUCATION POLICY (NEP 2020) REGULATIONS-2023

Definitions:

Terms used in the NEP-CBCS Regulations shall have the meaning assignedto 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 field work or community engagement and service per Semester.

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

c. "**Residence time"** means the time a student spends for 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 examinations andevaluation;

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. (CorporateEconomics)

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 being admitted into an ongoing Programme of the University otherwise than in the 1st year of the programme.

m. **"Vocational Studies/Education"** This refer to 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, 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 industry, businesses, artists, crafts persons etc. which will further improve employability.

Programmes to be offered at Colleges:

The Curriculum Framework designed by UGC for implementing NEP 2020 specifies that all Undergraduate(UG) degree programmes are to be from a period either for 3 years or for 4 years leading to award of UG or UG(Hons) Degrees.

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 4credits each)
2	Minor Discipline Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 creditseach)
3	Multi-Disciplinary Courses	9 Credits(3 courses of 3credits each)	9 Credits (3 courses of 3 creditseach)
4	Ability Enhancement Courses	8 Credits(4 courses of 2credits each)	8 Credits (4 courses of 2 creditseach)
5	Skill Enhancement Course	9 Credits(3 courses of 3credits each)	9 Credits (3courses of 3 creditseach)
6	Common Value added courses	8 Credits(4 course of 2credits each)	8 Credits (4 course of 2 creditseach)
7	Community Science	2 Credits(1 field basedcourse)	2 Credits (1 field based course)
8	Research Dissertation Project	-	12 Credits(Project report & background subjects)
9	Total credits required	120 Credits	160 Credits1

4.1. 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, Physics &Chemistry).

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

Minor disciplinary courses refer to those subjects which are Allied/Specialisation/Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. For example a B.A. (Political Science) student shall study allied subjects like Public Administration, Sociology as these subjects have inter linkages with the Major Disciplinary subjects.Minor disciplinary courses(MID) may also be designed by the parent department or collaborated with sister departments. Parent departments may introduce minor specialisations to students by offering a set of 6 to 8 courses in one/two streams as electives or specialisation subjects. A BBA/MBA programme may have electives in HR, marketing, finance, etc. with a set of 6 to 8 subjects in each.In order to provide choice to the students to choose a particular specialisation/elective, the BOS may develop 2 to 3 streams of minor specialisation courses to focus on such trades for better placemen of students. Each stream of 6/8 specialisation/elective subjects may facilitate 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 are mandated to pursue 9 credits worth of courses in such Multi-disciplinary areas/Courses out of 9/10 NEP defined subjects. Colleges may identify any 3 multiple disciplinary streams listed below based on availability of resources and manpower. (from Natural Sciences, Physical Sciences, Mathematics & Statistics, Computer Science/Applications, Data Analysis, Social Sciences, Humanities, Commerce & Management, Library Science, 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 atleast 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, writing skills. These courses are expected to enhance the ability in articulation and presentation of their thoughts at workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline. Eg. A course in Business Communication is more appropriate in place of literature/prose/poetry.

a) English Language

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

v) Skill Enhancement Course: (9 Credits)

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: (Understanding India, Environmental Sciences/Education, Digital and technological solutions, Health, Wellness, Yoga Education, Sports & Fitness)
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) Summer Internship (2 to 4 Credits)

As per the UGC guidelines all UG students should be exposed to 4 to 6 week Summer Internship in an industrial organisations/Training Centres/Research Institution, etc. Such Summer Internship is to be conducted in between 4^{th} Semester and 5^{th} semester. A review of report and award of grade based on Work based learning by students is to be recorded during the 5^{th} Semester.

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

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

viii) Research Project (12 Credits)

All UG (Hons) Degree students are expected to conduct a semester long Research work - during their 8^{th} 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 courses200 to 299 = Intermediate Level courses
300 to 399 = Core courses/Advanced courses400 and above = Specialization subjects

Semester –wise Break up of Courses for 3 year UG and 4 YearUG (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 **ANNEXURE - I**

NEP

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

Semester	Levels of Teaching	Major Disciplinary Courses (TotalCredi:60/80)	Minor Disciplinary Courses (Total credi: 24/32)	Multi-DisciplinaryCourses (Total Credits: 9)	Ability Enhancement courses (Total Credits: 8)	Skill EnhancementCourses (Total Credits: 9)	Value added /CommonCourse (Total Credits: 8)	Total Credits
I	100 Level	MJD – I Major DisciplinaryCourse - 1 **4 Cr**	MID-I Minor Disciplinary Course -1 (2 to 3 stream ofMinor) **4 Cr**	MLDC-I Multi-DisciplinaryCourse-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 commoncourses (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 Technology(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 DisciplineCourse (Total Credits: 24/32)**	**Multi-DisciplinaryCourse (Total Credits:9)**	**Ability Enhancement courses (Total Credits: 8)**	**Skill EnhancementCourses (Total Credits: 9)**	**Value added /CommonCourse (Total Credits:8)**	**Total Credits**
III	200 Level	MJD – III & IV Major DisciplinaryCourse - 3 Major DisciplinaryCourse - 4 **8 Cr**	MID-III Minor DisciplinaryCourse -3 (Allied/Elective)(4 Cr) **4Cr**	MDC-III Multi-DisciplinaryCourse-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 SemesterIII - 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 15days) **2 Cr**	Total courses in SemesterIV - 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 DisciplineCourse	Minor Discipline Course	Multi-DisciplinaryCourse	Ability Enhancementcourses	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 for60 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 DisciplineCourse (Total Credits80)	Minor DisciplineCourse (Total Credits32)	Multi-DisciplinaryCourse	Ability EnhancementCourses	Skill Enhancement Courses	Value added /CommonCourse	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 Practicals, 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:

Faculty member in-charge of Lab practicals shall evaluate thepractical 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 atleast 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 Worksubjects (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 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 pass during 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 to the said course in the following Semester. All other candidates who failed due to shortage of attendance, those who are seeking to improve the grade shall repeat the course.

Letter Grades and Calculation of CGPA:

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

Equivalent Letter Grade	Meaning	Grade Points for Calculationof 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 inany course.)

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit xGrade)
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 onecourse.)

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 twocourses.)

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A_{14}	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) / Research in MATHEMATICS WITH STATISTICS

OFFERED IN

AFFILIATED COLLEGES

PONDICHERRY UNIVERSITY

TO BE IMPLEMENTED WITH EFFECT FROM THE ACADEMIC YEAR (2023-24 onwards)

Implementation of NEP in Affiliated Colleges NEP courses structure from the Academic Year 2023-24

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 with Statistics (B.Sc Mathematics with Statistics)

Titles of Diplomas embodied (2 years):

UG Diploma in Mathematics (Dip. Mathematics)

Titles of Certificates embodied (1 year):

UG Certificate of Mathematics

I.LIST OF MAJOR COURSES (Single Major)

Sl No	Nature of Course	Title of the Course(Single Major)	Credits	No. Hrs of Teacher
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	Elements of Discrete Mathematics	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	Mathematical Modeling - Theory and Practical	4	5
9.	Major 9	Ring Theory	4	5
10.	Major 10	Complex Analysis-I	4	5
11.	Major 11	Programming Using SCILAB – Theory and Practical	4	5
12.	Major 12	Complex Analysis-II	4	5
13.	Major 13	Introduction to Linear Algebra	4	5
14.	Major 14	Graph Theory	4	5
15.	Major 15	Numerical Methods Using SCILAB – Theory and Practical	4	5
16	Major 16	Advanced algebra	4	5
17	Major 17	Topology	4	5
18	Major 18	Differential equations and special functions	4	5
19	Major 19	Advanced Real analysis	4	5

20	Major 20	Advanced Linear algebra	4	5
21	Major 21	1. Differential Geometry 2. Algebraic Number Theory 3. Advanced Topics in Topology and Analysis 4. Numerical Analysis for Ordinary Differential Equations 5. Advanced Topology 6. Integral Transforms and their Applications **Note:-** **Students shall choose any of the above three courses if they do not choose the Research Project/ Dissertation.**	4	5
22	Major 22		4	5
23	Major 23		4	5

1. In semester V, MJD-8 (Mathematical Modelling - Theory and Practical) and MJD-11 (Programming Using SCILAB - Theory and Practical) will each include two additional hours of practical work. Similarly, in semester VI, MJD-15 (Numerical Methods Using SCILAB - Theory and Practical) will include two additional hours of practical work.
2. 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 *

UG courses having different streams of specialisations may consider the minor stream Eg. B.Com(General), B.Com (Computer Science), B.Com (Foreign Trade), B.Com (Cooperative management), etc.

a) With Minor Stream I (Within the Department)

Sl No	Title of the Minor Course(Single Major)	Credits	No. Hrs of Teacher
Minor 1	Statistics-I	4	5
Minor 2	Statistics-II	4	5
Minor 3	Statistics-III	4	5
Minor 4	Statistics-IV	4	5
Minor 5	Operations Research - I	4	5
Minor 6	Operations Research - II	4	5
Minor 7	Calculus of variations	4	5
Minor 8	Integral equations	4	5

b) Minor Stream II (12 credits from the disciplines + 12 credits from discipline)

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

Sl No	Title of the Minor Course(Single Major)	Credits	No. Hrs of Teacher
Minor 1	Mathematics of Finance	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 B.Sc. in Physics , Chemistry, other science students(Other than Mathematics).**

Sl No	Title of the Minor Course(Single Major)	Credits	No. Hrs of Teacher
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 Transform	4	5
Minor 6	Numerical Analysis	4	5

III. MULTI DISCIPLINARY COURSES *

Sl No	Title	Credits	No. Hrs of Teacher
1.	Basics of Natural Science	3	4
2.	Basics of Physical Sciences	3	4
3.	Basics of Humanities & Social Sciences	3	4

***** Common syllabus for all UG courses, Deans of respective schools will design the syllabus

IV. ABILITY ENHANCEMENT COURSES *

a) English

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

b) Indian Language

SlNo	Title	Credits	No. Hrs of Teacher
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

VI. SKILL ENHANCEMENT COURSES (ONLINE COURSES FROM SKILL INDIA)

Sl No	Title of the Skill/Vocational courses	Credits	No. Hrs of Teacher
Skill 1	Quantitative Aptitude	3	4
Skill 2	Logical Reasoning	3	4
Skill 3	Latex	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 centres, BOS may also consider any other skill programmes that other Departments of the given institution. These may include skill training on computer programming, other emerging technologies.

VII. VALUE ADDED COMMON COURSES

SlNo	Title	Credits	No. Hrs of Teacher
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

Common course structure and syllabus shall be prepared by:
Dean, School of Social Sciences for subject 1
Dean, Scholl 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	MinorCourse1	4	5	Statistics-I
MLDC-I	Multi–Disciplinary Course 1	3	4	Natural Science
Natural AEC-I	Ability Enhancement Courses 1	2	4	English-1 or Indian Language - 1
SEC-I	Skill Enhancement Courses 1	3	4	Quantitative Aptitude
VAC-I	Value-added Courses 1 & 2	2	4	Understanding India (Theory/Field based)
VAC-II		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 Course2	4	5	Statistics-II
MLDC-II	Multi–Disciplinary Courses2	3	4	Physical Science
AEC-II	Ability Enhancement Courses 2	2	4	English-1 or Indian Language - 1
SEC-II	Skill Enhancement Courses 2	3	4	Logical Reasoning
VAC-III	Value-added Courses 3 & 4	2	4	Health, Wellness, Yoga Education, Sports & Fitness
VAC-IV		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	Elements of Discrete Mathematics
MID-III	MinorCourse3	4	5	Statistics - III
MLDC-III	Multi–Disciplinary Course 3	3	4	Humanities/ Social Sciences
AEC-III	Ability Enhancement Courses 3	2	4	English-2 or Indian Language - 2
SEC-III	Skill Enhancement Courses 3	3	4	Latex
Total Courses/ Credits/ Hours	6 Courses	20	27	

SEMESTER IV

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-V	Major Course5	4	5	Real Analysis - II
MJD-VI	Major Course 6	4	5	Group Theory
MJD-V11	Major Course 7	4	5	Elements of Differential Equations
MID-IV	Minor Course4	4	5	Statistics - IV
AEC-IV	Ability Enhancement Courses7&8	2	4	English-2 or Indian Language - 2
VAC-V	Community Engagement and Service	2	6	Community engagement NSS and other services
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	Mathematical Modeling-Theory and Practical
MJD-IX	Major Course 9	4	5*	Ring Theory
MJD-X	Major Course 10	4	5*	Complex Analysis- I
MJD-XI	Major Course 11	4	4+2	Programming Using SCILAB – Theory&Practical
MID-V	MinorCourse5	4	5*	Operations Research - I
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-XII	Major Course12	4	5*	Graph Theory
MJD-XIII	Major Course 13	4	5*	Introduction to Linear Algebra
MJD-XIV	Major Course 14	4	5*	Complex Analysis- II
MJD-XV	Major Course 15	4	4+2	Numerical Methods Using SCILAB – Theory& Practical
MID-VI	MinorCourse6	4	5*	Operations Research - II
Total Courses/ Credits/ Hours	5 Courses	20	26	

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

FOURTH YEAR

SEMESTER VII

Course Code	Type of Course	Credits	Hours	Title of the Course
MJD-XVI	Major Course16	4	5*	Advanced algebra
MJD-XVII	Major Course 17	4	5*	Topology
MJD-XVIII	Major Course 18	4	5*	Differential equations and special functions
MID-VII	Minor Course 7	4	5*	Calculus of variations
MID-VIII	Minor Course 8	4	5*	Integral equations
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-XIX	Major Course19	4	5*	Advanced Real analysis
MJD-XX	Major Course 20	4	5*	Advanced Linear algebra
		12	15	Research Project Dissertation
MJD-XXI	Major Course 21	4	5*	1. Differential Geometry 2. Algebraic Number Theory 3. Advanced Topics in Topology and Analysis 4. Numerical Analysis for Ordinary Differential Equations 5. Advanced Topology 6. Integral Transforms and their Applications **Note:-** **Students shall choose any of the above three courses if they do not choose the Research Project/ Dissertation.**
MJD-XXII	Major Course 22	4	5*	
MJD-23	Major Course 23	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 project and Dissertations.

II. 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 on the faculty. The number students may be restricted depending on the available classroom facility and first-cum-first serve basis.

a) With Minor Stream I (Within the Department)

Course Code	Type of Course	Credits	Hours	Title of the Course
MID-I	Minor Course 1	4	5	Statistics-I
MID-II	Minor Course 2	4	5	Statistics-II
MID-III	Minor Course 3	4	5	Statistics-III
MID-IV	Minor Course 4	4	5	Statistics-IV
MID-V	Minor Course 5	4	5	Operations Research-I
MID-VI	Minor Course 6	4	5	Operations Research-II
MID-VII	Minor Course 7	4	5	Calculus of variations
MID-VIII	Minor Course 8	4	5	Integral equations

b) With Minor Stream II

Course Code	Type of Course	Credits	Hours	Title of the Course
MID-I	Minor Course 1	4	5	Mathematics of Finance
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 (The subjects are for other discipline)

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

VI. Skill Enhancement Courses (Online Courses from Skill India)

Course Code	Offered in Semester	NEP Classification	Credits	Hours	Title of the Course
SEC-I	I	Skill 1	3	4	Quantitative Aptitude
SEC-II	II	Skill 2	3	4	Logical Reasoning
SEC-III	III	Skill 3	3	5	Latex

VII. Multi-Disciplinary Course for all Arts, Commerce, and Science students(Except mathematics)

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

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**

LIST OF MAJOR COURSES (SINGLE MAJOR)

I YEAR : SEMESTER – I
MAJOR - 1 : CALCULUS – 4 CREDITS (60 HOURS)

UNIT I :
nth derivative – Standard results – Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula

UNIT II :
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

UNIT- III :
Circle, radius and centre of curvature – Cartesian formula for radius of curvature – envelope

UNIT- IV :
Integration of rational algebraic functions – Integration of irrational algebraic functions - Properties of definite integrals

UNIT- V :
Integration by parts – reduction formula, Bernoulli's formula - Evaluation of double integral (Cartesian form only) – Triple integral (Cartesian form only)

Prescribed Text(specify sections clearly)
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

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,

Reference books
1. Integral Calculus, N. P. Bali, Laxmi Publications, Delhi, (1991)
2. 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.

I – YEAR : SEMESTER - II

MAJOR – 2 : MATRICES AND THEORY OF EQUATIONS – 4 CREDITS (60 HOURS)

Course Objectives:

1. To introduce the idea of matrices and to learn about the algebra of matrices
2. To solve system linear equations using matrix Theory

	Course Outcome
CO 1	To learn the relation between the co-efficient and roots of polynomial equations.
CO 2	To learn various methods for solving polynomial equations and study the nature & position of roots.
CO 3	Analytic Methods for solving the polynomial equation of degrees 3 & 4.

Unit I: (Section 1.1, 1.2, 1.3,1.4,1.5 of [1])

Linear systems - Matrices - Dot product and Matrix multiplication - Properties of Matrix operation, Matrix transformations.

Unit II: (Section 1.6,1.7,1.8[1])

Solutions of Linear systems of equations - Row echelon from reduced row echelon form – Polynomial interpolation - The inverse of a Matrix. - Linear Systems and inverses - LU- Factorization Method.

Unit III: (Sections 5.1,5-2,.5.3 of [2])

Division algorithm - Relation between roots and coefficients - Sum of the powers of the roots.

Unit IV: (section 5.4,5.5,5.6 ,5.7 of [2])

Reciprocal equations - Transformation of equations: - Multiple roots - Nature of position of roots - Sturm's Theorem.

Unit V: (5.8,5.9,5.10 of [2])

Cardan's Method for solving Cubic equations – Ferrari's Method for solving biquadratic equations - New Newton's Method- Horner's Method

Text Books

1. Bernard Kolman Drid R. Hill, Introductory Linear Algebra, (8e),Pea rson India (2011)
2. S. Arumugam and A Thangaand Isaac, Set Theory Number System and Theory of Equations, New Gamma publishing house(1997.).

References:

1. Theory of Equations, Hari Kishan, Atlantic Publishers, 2022

2.Theory of Equations, Lalji Prasad, New Revised Edition, 2016

II YEAR : SEMESTER - III

MAJOR – 3 : REALANALYSIS-I – 4 CREDITS (60 HOURS)

UNITI :

Sets and elements — Operations on sets — Functions - Real valued functions-Equivalence— Countability— Real numbers—Least upper bound—Greatest lower bound.

UNITII :

Definition of sequence and subsequence — Limit of a sequence —Convergent sequence — Bounded sequence Monotone sequence -Operationonconvergentsequence-Limitsuperiorandlimitinferior—Cauchysequence

UNITIII :
Convergence and divergence- Series with non - negative terms -Alternating series—Conditional convergence and absolute convergence-Tests for absolute convergence-Series whose terms formanon- increasing sequence—Summation by parts.

UNITIV :

Limit of a function on the real line - Metric spaces (Examples 4 and 5under4.2cto be omitted)-Limits in metric spaces.

UNITV :

Functions continuous at a point on the real line Reformulation —Functions continuous on a metric space - Open sets and closed sets –Discontinuous functions on R

Prescribed Text

Methods of Real Analysis, Treatmentasin Richard R.Goldberg(1970)
Unit1 :Chapter1
Unit2,3:Chapter2andChapter3(upto3.8)
Unit4 :Chapter4
Unit5 :Chapter5

ReferenceBooks

1. *A First Course in Mathematical Analysis- D Somasundaram & BChoudhyri-Narosa Publishing houseNew Dehli*
2. *Introduction to Calculus and Analysis, Vol.I, Richard Courant and Fritz John, Springer 1999.*
3. *IntroductiontoRealAnalysis,4th Edition, Robert G.Bartle and Donald R.Sherbert,Wiley-2014.*

e-LearningSource :
http://ndl.iitkgp.ac.in
http://ocw.mit.edu
http://mathforum.org

MAJOR – 4 : ELEMENTS OF DISCRETE MATHEMATICS – 4 CREDITS (60 HOURS)

Course Objectives:

1. Able to understand the concepts of sets and determine whether a relation is a function and identify the domain and range of a function.
2. Understand the ideas of the basis step and the inductive step in a proof by Mathematical induction and recurrence relations

	Course Outcome
CO 1	To understand the basic concepts of Permutations and combinatorics
CO 2	To familiarize the applications of Difference sequences and Catalan numbers.
CO 3	To understand the concepts and significance of lattices and Partition of numbers.

Unit I:

The Integers – The Division algorithm – Divisibility – The Euclidean Algorithm – Prime numbers.

Unit II:

Mathematical induction – Weak form and strong form – Recursively defined sequences – Solving recurrence relations – The characteristic polynomials – Solving recurrence relations – Generating functions – The principle of inclusion- Exclusion – The addition and multiplication rules.

Unit III:

The pigeonhole principle–Permutations – Combinations –Repetitions – Derangements – The binomial theorem.

Unit IV:

Catalan numbers – Difference sequences - stirling numbers of the first kind and second kind.

Unit -V:

Partition of numbers – Ferrers diagram – A geometric application – Lattice Paths – Schroder numbers.

Text Books

1. **Edgar G. Goodaire, Michael M. Parmenter , Discrete Mathematics with Graph Theory (Third Edition), PHI Learning Private Ltd., New Delhi – 2011.**
2. **Richard A. Brualdi, Introductory Combinatorics, (Fourth Edition), Pearson Education 2004.**

Reference Books

1. Richard Johnsonbauth, Discrete Mathematics – 5th Edition,–, Pearson Education Asia, New Delhi, 2002.
2. Ralph. R. Grimaldi - Discrete and Combinatorial Mathematics: An applied Introduction – 4th Edition, Pearson Education Asia, Delhi, 2002
3. C.L. Lie, Elements of Discrete Mathematics — the Mc Graw-Hill, Inc. India 1985.
4. Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, Discrete Mathematical Structure, 4th Edition print Pearson Education Pvt. Ltd., New Delhi 2003

II - YEAR : SEMESTER - IV

MAJOR – 5 : REALANALYSISII – 4 CREDITS (60 HOURS)

UNIT I:

More about open sets - Connected sets. Bounded sets and totally bounded sets - Complete metric spaces.

UNIT II:

Compact metric spaces Continuous functions on compact metric Spaces - Continuity of the inverse function - Uniform continuity.

UNIT III:

Sets of measure zero - Definition of the Riemann integral - Existence of the Riemann integral- Properties of the

Riemann integral

UNIT IV :

Derivatives - Rolle's theorem - The Law of the Mean - Fundamental theorem of Calculus - - Improper integrals.

UNIT V:

Hyperbolic function - The exponential function - The logarithmic function - Definition of xa - The trigonometric function - Taylor Theorem -L'Hopital's rule.

Prescribed Text

Methods of Real Analysis, Treatment as in Richard R. Goldberg, (1970)

Unit 1: 6.1 to 6.4 Unit 2: 6.5 to 6.8 Unit 3: 7.1 to 7.4

Unit 4: 7.5 to 7.10 Unit 5: 8.1 to 8.7 Reference Books

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

2. Real Analysis- byShanti Narayanan

e-Learning Source

http://ndl.iitkgp.ac.in

http://ocw.mit.edu

http://mathforum.org

MAJOR – 6 : GROUP THEORY – 4 CREDITS (60 HOURS)

Course Objectives:

1. To understand groups and sub groups
2. To understand quotient groups- Homomorphism.

Unit I **(12 hours)**

Introduction to Groups - Definition and Examples of Groups – Elementary Properties of Groups – Subgroups - Subgroup Tests - Examples of Subgroups.

Unit II **(12 hours)**

Cyclic Groups - Properties of Cyclic Groups - Classification of Subgroups of Cyclic Groups - Permutation Groups - Cycle Notation - Properties of Permutations.

Unit III **(12 hours)**

Isomorphisms - Cayley's Theorem - Properties of Isomorphisms – Automorphisms - Properties of Cosets - Lagrange's Theorem and Consequences.

Unit IV **(12 hours)**

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 Groups - Internal Direct Products.

Unit V **(12 hours)**

Group Homomorphisms - Properties of Homomorphisms - The First Isomorphism Theorem - Fundamental Theorem of Finite Abelian Groups - The Isomorphism Classes of Abelian Groups.

Text Book:

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

Reference books

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

MAJOR – 7 : ELEMENTS OF DIFFERENTIAL EQUATIONS – 4 CREDITS (60 HOURS)

Course Objectives:

1. To understand ordinary and first order partial differential equations and their applications
2. To enable students to understand solving the first and second order ODES and first order PDEs.

	Course Outcome
CO 1	To solve a system of first order ODEs
CO 2	To analyze the stability of a Dynamical System using Differential Equations and their solutions
CO 3	To Solve First Order Partial Differential Equations

Unit I:

Exact differential equations- Integrating factors – Linear differential equations- Bernoulli equation – Modeling: Electric circuits – Orthogonal trajectories of curves.

Unit II:

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.

Unit III:

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.

Unit IV:

Introduction: vectors, matrices, eigenvalues – Introductory examples – Basic concepts and theory – Homogeneous systems with constant coefficients, phase plane, critical points – Criteria for critical points, Stability.

Unit V:

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

Text Book

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, 2.13, 2.14;
Unit-IV: Sections 3.0-3.4;
K. Shankara Rao, Introduction to Partial Differential Equations, PHI Publications, 3rd Edition. 2011. – Chapter 1

Reference Books

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.

III – YEAR : SEMESTER - V

MAJOR – 8 : MATHEMATICAL MODELING–THEORY & PRACTICAL – 4 CREDITS

(60 HOURS)

Course Description: This course introduces undergraduate students to the fundamentals of mathematical modeling and its applications. Students will learn to formulate, analyze, and solve real-world problems using mathematical techniques covered in the textbook.

Course Objectives: By the end of the course, students should be able to:

1. Understand the modeling process and its importance in various disciplines.
2. Formulate mathematical models for real-world problems using difference equations, proportionality, and geometric similarity.
3. Fit models to data and make data-driven decisions.
4. Conduct experimental modeling and choose appropriate models for given data.
5. Perform simulation modeling to analyze deterministic and probabilistic behavior.

Unit 1: Modeling Change with Difference Equations

Introduction to Mathematical Modeling, Modeling Change with Difference Equations, Approximating Change with Difference Equations, Solutions to Dynamical Systems, Systems of Difference Equations

Unit 2: Proportionality and Geometric Similarity

Introduction to Proportionality and Geometric Similarity, Mathematical Models, Modeling Using Proportionality, Modeling Using Geometric Similarity, Automobile Gasoline Mileage, Body Weight and Height, Strength and Agility

Unit 3: Model Fitting and Data Analysis

Introduction to Model Fitting, Fitting Models to Data Graphically, Analytic Methods of Model Fitting, Applying the Least-Squares Criterion, Choosing a Best Model

Unit 4: Experimental Modeling

Introduction to Experimental Modeling, Harvesting in the Chesapeake Bay and Other One-Term Models, High-Order Polynomial Models, Smoothing: Low-Order Polynomial Models, Cubic Spline Models

Unit 5: Simulation Modeling

Introduction to Simulation Modeling, Simulating Deterministic Behavior: Area Under a Curve, Generating Random Numbers, Simulating Probabilistic Behavior, Inventory Model: Gasoline and Consumer Demand, Queuing Models

Text Book: A First Course in Mathematical Modeling, by Frank R. Giordano, Maurice D. Weir, and William P. Fox

MAJOR – 9 : RING THEORY – 4 CREDITS (60 HOURS)

Unit I **(12 hours)**

Introduction to Rings - Motivation and Definition of Rings – Examples of Rings – Properties of Rings – Subrings - Definition and Examples of Integral Domains – Fields - Characteristic of a Ring.

Unit II **(12 hours)**

Ideals - Factor Rings - Prime Ideals and Maximal Ideals - Definition and Examples of Ring Homomorphisms - Properties of Ring Homomorphisms - The Field of Quotients.

Unit III **(12 hours)**

Polynomial Rings - The Division Algorithm and Consequences - Principal ideal domain - Factorization of Polynomials - Reducibility Tests - Irreducibility Tests.

Unit IV **(12 hours)**

Unique Factorization in $Z[x]$ - Weird Dice: An Application of Unique Factorization - Divisibility in Integral Domains – Irreducibles and Primes.

Unit V **(12 hours)**

Historical Discussion of Fermat's Last Theorem - Unique Factorization Domains - Euclidean Domains.

Text Book:

Joseph A. Gallian, Contemporary Abstract Algebra, 8th Edition, Cengage Learning India Private Limited

Chapter 12 to Chapter 18

Reference books

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

MAJOR – 10 : COMPLEX ANALYSIS – I – 4 CREDITS (60 HOURS)

UNITI:

Complex numbers-Definitions-Algebraic properties–Cartesian co-ordinates - Triangular inequality - Polar Form - Powers and roots -Region in the complex plane.

UNITII:

Analytic functions - Functions of a complex variable -Mapping -Limit - heorems on limits - Continuity - Derivatives -Differentiation formula-Cauchy Riemann equations–Sufficient conditions.

UNITIII:
Cauchy Riemann equations in polar form - Analytic functions -Harmonicfunctions.

UNITIV:
Elementary functions - Exponential function – Trigonometric functions and their--properties-Hyperbolic functions–Logarithmic function – Branches - properties of logarithms - Complex exponents -Inverse trigonometric & hyperbolic functions.

UNITV:
Mapping by elementary functions - The linear function 1/z – Linear fractional transformation-The function w=exp(z),W=sin z, W=Cos z,$z^{1/2}$-Successive transformation W= z+1/z.

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

Reference Books

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,FoundationsofComplexanalysis,(2nd Edition),Narosa,2011.*

V.Karunakaran, Complex Analysis,(2nd Edition),Narosa2005

e-Learning Source
http://ndl.iitkgp.ac.in

MAJOR – 11 : PROGRAMMINGUSINGSCILAB–THEORY & PRACTICAL - 4 CREDITS

(60 HOURS)

UNIT I:

Overview of Scilab - How to get started with Scilab - Getting help from Scilab demonstrations and macros – The Console – The Editor – Batch Processing Creating Real Variables - Elementary mathematical functions – Booleans – Complex Numbers – Integrers – Floating Points – Strings – Dynamic Variables

UNIT II:

Matrices – Create Matrices of Real Variables – Accessing Elements of Matirces - Matrices are dynamic – Elementwise Operations Conjugate transpose and non-conjugate transpose - Multiplication of two vectors Comparing two real matrices - Issues with floating point integers - More on elementary functions - Higher-level linear algebra features

UNIT III:

Looping and branching - The if , select , for and while statements The break and continue statements Functions - Function libraries - Managing output arguments Levels in the call stack - The return statement - Debugging functions with pause

UNIT IV:

Plotting - 2D plot - Contour plots - Titles, axes and legends - Export

UNIT V:

Solving Ordinary Differential Equations using Scilab

Prescribed Text

Introduction to Scilab- Michael Baudin From Scilab Consortiun, 2010Chapters 1to 8 (Book Freely Downloadable in Internet)

1. *Plotting Using Scilab –AnopenSourceDocument–www.openeering.com*

Reference Books

1. *Modeling and Simulation in Scilab,Stephen L. Campbell, Jean-PhilippeChancelierand Ramine Nikoukhah*
2. *An Introduction to Scilab from a Matlab User's Point of View by Eike Rietsch*

e-LearningSource

http://ndl.iitkgp.ac.inhttp://ocw.mit.edu
http://mathforum.org

MAJOR – 12 : COMPLEXANALYSIS-II– 4 CREDITS (60 HOURS)

UNITI:
Contour integrals- Examples - The Cauchy Goursat's theorem -A preliminary lemma- Proof of Cauchy Goursat's theorem -Simply and multiple connected domains.

UNITII:
The Cauchy integral formula -Derivatives of analytic functions-Morera's theorem - Maximum moduli of functions-Liouville's theorem-The fundamental theorem of algebra.

UNITIII:
Convergence of sequences and series - Taylor series -Observations and examples–Laurent Series (statement only).

UNITIV:
Singularities-Definitions and examples-Residues-The residue theorem - The principal part of a function-Residues and poles – zeros and poles of order m.

UNITV:

$$Type\ 1: \int_{-\infty}^{\infty} \frac{p(x)}{q(x)}\,dx$$

$$Type\ 2: \int_{-\infty}^{\infty} \frac{p(x)}{q(x)} \sin ax\,dx\ (or) \int_{-\infty}^{\infty} \frac{p(x)}{q(x)} \cos ax\,dx$$

$$Type\ 3: \int_{0}^{2\pi} F(\sin\theta, \cos\theta)\,d\theta$$

Where p(x) and q(x) are real polynomials with no factor in common and q(x) has no real zeros.

Prescribed Text
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
UnitV:Chapter 6:Section58-60

Reference Books
1. *Functions of a Complex variable by B. S. Tyagi – KedarNath RamNathPublishers(P)Ltd.*
2. *Complex Analysis by P. Duraipandian and KayalalPachaiappa –S.Chand&Co.*
3. *S. Ponnusamy, Foundations of Complex analysis, (2nd Edition), Narosa,2011.*
   V.Karunakaran,ComplexAnalysis,(2ndEdition),Narosa2005

e-LearningSource
http://ndl.iitkgp.ac.in
http://ocw.mit.edu
http://mathforum.org

MAJOR – 13 : INTRODUCTION TO LINEAR ALGEBRA – 4 CREDITS (60 HOURS)

Course Objectives:

1. To understand vector spaces by its definition and examples.
2. To know how to represent a linear transformation by a matrix

	Course Outcome
CO 1	To learn elementary operations on Matrices and how to apply them to find the solutions of a system of equations
CO 2	To learn the properties of determinant of matrices
CO 3	To know about inner products and orthogonalization

Unit I:

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.

Unit II:

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.

Unit III:

Elementary matrix Operations and elementary matrices- The rank of a matrix and matrix inverses- systems of linear equations- Theory and computation

Unit IV:

Determinants of order 2 and order n- propertie4s of determinants- Important facts about determinants- Eigen values and Eigen vectors- Diagonalizability- Invariant spaces and Cayley- Hamilton theorem.

Unit V:

Inner products and norms- The Gram-Schmidt orthogonalisation process and orthogonal complements.

Text Book

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

Reference Books

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.
3. David C. Lay, Linear Algebra and Applications (2nd Edition), Addison Wesley, 1997.
4. John B. Fraleigh, A First Course in Abstract algebra, (7th Edition), Pearson 2013.

MAJOR – 14: GRAPH THEORY – 4 CREDITS (60 HOURS)

Course Objectives:

1. To introduce the notion of graphs and the basic terminologies in graphs
2. To learn the concept of spanning trees, Cayley's formula and to introduce the concept of connectivity and edge connectivity of graphs

Unit I:

Graphs – Subgraphs – Isomorphism of graphs – Degrees of Vertices – Paths and Connectedness – Automorphism of a Simple Graph – Trees – Centers and Centroid.

Unit II:

Counting the Number of Spanning Trees – Cayley's Formula– Vertex Cuts and Edge Cuts – Connectivity and Edge-connectivity.

Unit III:

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).

Unit IV:

Eulerian graphs – Necessary and sufficient condition for Eulerian graphs – Hamiltonian graphs – Dirac theorem –Closure of a graph.

Unit V:

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.

Text Book:-

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.

Reference Books:-

1. Bondy, J.A and Murthy, U.S.R, Graph Theory with Applications, Macmillan Press Ltd, New Delhi – (1976).Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi-2011.
2. G. Chartrand, Linda Lesniak and Ping Zhang, Graphs and Digraphs, Fifth Edition, CRC press 2011.

MAJOR – 15: NUMERICAL METHODS USING SCILAB THEORY & PRACTICAL

– 4 CREDITS (60 HOURS)

UNIT I:

Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.

UNIT II:

Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.

UNIT III:

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.

UNIT IV:

Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.

UNIT V:

Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.

Text book

Numerical Method in Science and Engineering,
M.K.Venkataraman,NationalPublicationCo,Chennai(2001)
Unit1: Chapter 3 and 4
Unit2: Chapter 5
Unit3: Chapter 6 and 9
Unit4:Chapter11(Relevantportions)Unit5:Chapter11(Relevantportions)

ReferenceBooks

ComputerorientedNumerical MethodsbyV.Rajaram–PHI(P)Ltd.

e-LearningSource

http://ndl.iitkgp.ac.in
http://ocw.mit.edu
http://mathforum.org

IV – YEAR : SEMESTER – VII

MAJOR-16 ADVANCED ALGEBRA (4 CREDITS- 60HOURS)

Course Objectives:

1. To learn isomorphism theorems group actions
2. To study about class equations and sylow theorems and its applications

	Course Outcome
CO 3	To know the direct product of groups and classifications of groups by applying the fundamental theorem finitely generated Groups
CO 4	To know the properties of Euclidean domain, Principal ideal domain and Unique factorization domain.
CO 5	To study the properties of Polynomial rings.

Unit I:

The isomorphism theorems -Composition Series - Transpositions and Alternating groups,

Unit II:

Group Actions: Group Actions and Permutation representations-Group acting on themselves by left multiplication-Cayley's theorem

Unit III:

Group acting on themselves by conjugation -The class equation- Automorphisms-The Sylow theorems- The simplicity of A_n.

Unit VI:

Direct and semi-direct products and abelian groups: Direct products- The fundamental theorem of finitely generated abelian groups.

Unit V:

Polynomial rings: Definitions and basic properties- Polynomial rings over fields- Polynomial rings that are unique factorization domains -Irreducible criteria.

Text Book:

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

Reference books

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.

MAJOR-17 TOPOLOGY (4 CREDITS- 60 HOURS)

Course Objectives:

1. To introduce the notion of metric spaces and to characterize open sets in the real line
2. To study the concept of topological spaces and to study their properties like second count ability and separability

	Course Outcome
CO 1	To discuss in details about compactness of topological spaces and to prove the Tychnoff's theorem with some applications
CO 2	To study bout the equivalent versions of compactness in metric spaces
CO 3	To discuss some important theorems like Urysohn's lemma and the Tietze extension theorem. Also, we study about connected spaces

Unit I: (Revision of Sections 1-3, Section 4-8, 9-12)

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.

Unit II: (Sections 16, 17 and 18)

Topological spaces -- Definitions and examples - Closure and related concepts – Open bases and open sub bases – Separability and second count ability -Lindloff's Theorem

Unit III: (Sections 21 – 23)

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.

Unit IV: (Sections 24,26)

Compactness for metric spaces – Sequential compactness - Lebesgue covering lemma - Sequential compactness and compactness coincide on metric spaces - T_1spaces - Hausdorff spaces.

Unit V: (Sections 27,28,31,32)

Completely regular spaces and normal spaces – Urysohn's lemma and Tietze extension theorem- –Connected spaces – Components of a space.

Text Book

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

Reference Books

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.

MAJOR-18 DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS
(4 CREDITS- 60 HOURS)

Course Objectives:

1. To study the qualities properties of ordinary differential equations.
2. To study the hypergeometric functions, Bessel functions and Legendre polynomials which arising as solution of ODEs

	Course Outcome
CO 1	To study the series solutions of ODEs,
CO 2	To study the existence and uniqueness of solutions of first order ODEs.

Unit I: [Chapter-4, Sections: 25, Chapter-5, Sections: 26, 27, 28, 29, 30 & Chapter -7, Sections: 40 of [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

Unit II: [Chapter-5, Sections: 31 of [1] & Chapters: 4 & 7 of [2]]
Gauss Hypergeometric equations. Gauss's hypergeometric and Confluent hypergeometric functions, integral representations, differentiation formulas, transformation formulas, summations formulas.

Unit III: [Chapter-8, Sections: 44, 45, 46 47 of [1]]
Legendre polynomials – Properties of Legendre polynomials – Bessel functions- The Gamma function - Properties of Bessel Function.

Unit IV: [Chapter-10, Sections: 55, 56 of [1]]
Linear systems – Homogeneous linear system with constant coefficients.

Unit V: [Chapter-13, Sections: 68, 69 of [1]]
The existence and uniqueness of solutions – The method ofsuccessive approximations – Picards's theorem.

Text Book

1. G. F. Simmons, Differential Equations with Applicationsand Historical Notes, 2nd Edition, McGraw Hill Education(India) Company, 2003. Sections: 22-30, 32-35, 37-355-56.
2. E. D. Rainville, Special *functions*, Macmillan, New York, 1960.

References

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.

IV – YEAR : SEMESTER – VIII

MAJOR-19 ADVANCED REAL ANALYSIS (4 CREDITS- 60 HOURS)

Course Objectives:

1.To study about functions of bounded variation, double sequence, double series and infinite products 2.To study about convergence of sequences and series of functions and their properties

	Course Outcome
CO 1	To prove some famous theorems like Weierstrass approximation theorem and stone Weierstrass theorem
CO 2	To study about differentiability of functions of several variables and to prove the contraction mapping theorem.
CO 3	To prove the important theorems- The inverse function and the implicit function theorem

Unit I:(Chapter:6 and Sections: 8.20 to 8.23, 8.26 and8.27 of [2])

Functions of bounded variation - Double sequences - Double series - Rearrangement theorem for double series- A sufficient condition for the equality of iterated series.

Unit II: (Chapter: 7 of [1], Subsections 7.1 to 7.25)

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

Unit III:(Chapter: 7 of [1] subsections: 7.26 to7.33 and chapter 8 of [1])

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.

Unit IV: (Chapter:9 of [1], Subsections: 9.6 to 9.23)

Functions of Several Variables - Linear Transformation - Differentiation - The Contraction Principle.

Unit V:(Chapter: 9 of [1], Subsections:9.24 to 9.38)

The inverse function Theorem - The implicit Function Theorem - The Rank Theorem – Determinants.

Text Books

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

Reference Books

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.

MAJOR 20-ADVANCED LINEAR ALGEBRA (4 CREDITS- 60H0URS)

Course Objectives:

1. To understand linear transformations Characteristic roots- Similarity of linear transformations, Invariant subspaces and matrices.
2. To understand triangular forms- Nilpotent transformations.

	Course Outcome
CO 1	To understand Jordan forms- Fundamental theorem on modules over PID.
CO 2	To understand Rational canonical form- Trace- Transpose & Determinants.
CO 3	To understand Hermitian - Unitary and Normal transformations - Real quadratic forms.

Unit I: Sections – 6.1,6.2, 6.3 [1] and 13.1-13.2 [2]

Field theory: Splitting fields and Algebraic closures. The Algebra of linear transformations-Characteristic roots- Similarity of linear transformations.

Unit II: Sections – 6.4 and 6.5 [1]

Invariant subspaces and matrices. Reduction to triangular forms.

Unit III: Sections – 6.6 and 4.5 [1]

Nilpotent transformations - Index of nil potency and invariant of nilpotent transformation. Jordan blocks and Jordan forms-

Unit IV: Sections - 6.7, 6.8 and 6.9 [1]

Modules - Cyclic modules - Fundamental theorem on modules over PID- Rational canonical form- Trace- Transpose and Determinants.

Unit V: Sections – 6.10 and 6.11 [1]

Hermitian - Unitary and Normal transformations - Real quadratic forms.

Text Book: 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)

Reference Books

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, (4^{th} Edition) Pearson, 2015.

MAJOR 21, MAJOR 22, MAJOR 23 shall be chosen from the following MAJOR subjects

DIFFERENTIAL GEOMETRY (4 CREDITS - 60 HOURS)

Course Objectives:

1. To learn about parametric curves, level curves and the notion of curvation of plane curves

2. To study about the properties of space curves, Serret Frenet equations and the four vertex theorem

Course Outcome	
CO 1	To study about surfaces, quadratic surfaces, triple orthogonal systems
CO 2	To calculate the length of curves on surfaces and surface area
CO 3	To study about the normal and principle curvature of curves on a surface and Euler's theorem

Unit I: [Sections: 1.1 to 1.4 and Sections 2.1,2. 2.]
Curves- arc length- Reparametrization-Level curves - Curvature - Plane curves.

Unit II: [Sections 2.3 and Sections 3.1 to 3.3.]
Space curves-Torsion- Serret Frenet equations- Simple closed curves- The Isoperimetric Inequality- The Four vertex Theorem.

Unit III: [Sections 4.1 to 4.7]
Smooth surface- Tangents, normal and orient ability- Examples of surfaces- Quadratic surfaces- Triple orthogonal systems- Applications of Inverse function theorem

Unit IV: [Sections: 5.1 to 5.5]
Lengths of curves on surfacesa- First fundamental form- Isometries of surfaces- Conformal mapping of surfaces-Surface area- Equiareal maps and a theorem of Archimedes.

Unit V: [Sections: 6.1 to 6.4]
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.

Text Book:

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

Reference Books:

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.

ALGEBRAIC NUMBER THEORY (4 CREDITS- 60 HOURS)

Course Objectives:

1. To study about the application of unique factorization in integers
2. To find the primes of Gaussian integers

Course Outcome	
CO 1	Construction of transcendental numbers using Liouville's theorem
CO 2	To study about the integral basis and discriminant of algebraic number fields
CO 3	To study about Dedekind domains.

Unit I: Elementary Number Theory (Sections 1.1 and 1.2)

Integers – Greatest common divisor – Infinitude of primes – Unique factorization in Z – Fermat's little theorem – Euler's Φ function and Euler's theorem – Multiplicative property of Φ function – Applications of unique factorization – The equation $x^2 + y^2 = z^2$ – The equation $x^4 + y^4 = z^2$ – The equation $x^4 - y^4 = z^2$ – Fermat numbers and their properties.

Unit II: Euclidean Rings(Sections 2.1, 2.2 and 2.3)

Preliminaries: Units, Associates, Irreducible elements, Norm map, Unique factorization domain, Principal ideal domain, Euclidean domain – Gauss' lemma – Gaussian integers – Units and primes in the ring of Gaussian integers – Eisenstein integers – Units in the ring of Eisenstein integers – Factorization of 3 – Order of $Z[\rho] / (\lambda)$.

Unit III: Algebraic Numbers and Integers (Sections 3.1, 3.2 and 3.3)

Basic concepts – Algebraic number – Algebraic integer – Minimal polynomial Count ability of algebraic numbers – Liouville's theorem for R – Algebraic number fields – Theorem of the primitive element – Liouville's theorem for C – Characterization of algebraic integers.

Unit IV: Integral Bases (Sections 4.1, 4.2 and 4.3)

The norm and the trace – Integral basis for an algebraic number field – Algebraic integers of $Q(\sqrt{-5})$ – Existence of an integral basis – Discriminant of an algebraic number field – Index – Determination of an integral basis for the ring of integers of a quadratic number field.

Unit V: Dedekind Domains (Sections 5.1 and 5.2)

Integral closure – Integrally closed ring – Noetherian ring – Dedekind domain – Characterizing Dedekind domains.

Text Book

J. E. Smonde and M. RamMurty, Problems in Algebraic Number Theory,
Graduate Texts in Mathematics, Volume 190, Springer Verlag, New York,1999.

Reference Books:

1. Pierre Samuel and Allan J Silberger, Algebraic Theory of Numbers, Dover Pub. Inc, 2008.

ADVANCED TOPICS IN TOPOLOGY AND ANALYSIS (4 CREDITS- 60 HOURS)

Course Objectives:

1. To study metrization theorem.
2. To study about the dual of $L_p[a,b]$.

Course Outcome	
CO 1	To learn the quotient topology and path connectedness
CO 2	To learn Urysohn Metrization theorem and compactification
CO 3	To learn about the completeness of $L_p[a,b]$

Unit I: (Sections 22,25, relevant parts from section 24 of [1])

Quotient topology and quotient maps - Examples of quotient spaces - Path connectedness - Standard results - Example of a connected but not path connected space- Locally connected spaces.

Unit-II: (Sections29, 34,38, 43,44 of [1])

The Uryshon's metrization theorem – Locally compact spaces-One point compactification - Stone- Cech compactification – The uniform metrric on Y_J and the Space filling curve.

Unit-III: (Sections 39, 40,41 of [1])

Local finiteness- Countably locally finite refinement of open coverings of metric spaces – Paracompactness - Standard results - Metric spaces are paracompact.

Unit-IV: (Chapter:7 of [2])

L_p- spaces – Completeness - Dual of $L_p[a,b]$for $1 \leq p < \infty$.

Unit-V: (Sections 8.1, 8.2 and 8.3 from Chapter:8 of [2])

Weak sequential convergence of $L_p[a,b]$ – the Riemann Lebesgue lemma – the Radon Riesz theorem - weak sequential compactness of $L_p[a,b]$.

Text Books:

1. James R. Munkres, Topology by James R. Munkres, Pearson, 2nd edition, 2000.
2. H.L.Royden, and P.M. Fitzpatrick, Real Analysis, (Fourth Edition) PHI Learning Private Limited, 2013.

Reference Books:

1. James Dugundji, General Topology, Allyn and Bacon, Inc.(1966).
2. Inder K. Rana, *An Introduction to Measure Theory and Integration, (2e)*, Narosa (2007).
3. B.V. Limaye, Functional Analysis, Wiley Eastern, New Delhi, 1981.

NUMERICAL ANALYSIS FOR ORDINARY DIFFERENTIAL EQUATIONS
(4 Credits – 60 HOURS)

Objectives:
To study various numerical methods to solve ordinary differential equations such as Euler's method, Gaussion quadrature and Error Control.

Unit-I
Euler's method - Trapezoidal rule - Theta method.

Unit-II
Adams - Bashforth method - Order and convergence - Backward differentiation formula.

Unit-III
Gaussion quadrature - Explicit Runge - Kutta scheme - Implicit Runge Kutta scheme - Collocation.

Unit-IV
Stiff equations - Linear stability domain and A- Stability -- A-stability of RK and multistep methods.

Unit-V
Error Control - Milne Device - Embedded Runge Kutta method.

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

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

ADVANCED TOPOLOGY (4 CREDITS- 60 HOURS)

Course Objectives:

1. To study about the notions of local connectedness, local compactness and one point compactification
2. We study about nets, filters and quotient topology

Course Outcome	
CO 1	We study about Stone -Cech Compactification and some Metrization theorems
CO 2	To learn about space filling curve and the imbedding theorem for compact metrizable spaces
CO 3	To study about fundamental groups and covering spaces

Unit I: (Sections- 25 and 29 of [1])
Connected components- Local connectedness - Locally path connected spaces- Local compactness, One point Compactification, Uryshon Metrization Theorem.

Unit II:(Chapter-10 of [2] and Sections- 22 and 36 of [1])
Nets and Filters- Quotient topology- Introduction to topological groups.

Unit III:(Sections-38, 39, 40, 41 and 42 of [1])
The Stone -Cech Compactification- Locally finite spaces- Nagata- Smirnov Metrization theorem- Paracompactness- Smirnov Metrization theorem.

Unit IV: (Sections-44 48 and 49 of [1])
The Peano space-filling curve – Barie Spaces – Nowhere differentiable functions.

Unit V: (Sections 48, 49, of [1])
Homotopy of paths- The fundamental group- Covering spaces- The fundamental group of the circle.

Text Books:

1. James R. Munkres, Topology, Second edition, Pearson Education Inc.,(2002).
2. K.D.Joshi, Introduction to General Topology, First edition (revised), New Age International Publishers, 2004.

Reference Books:

1. Stephen Willard, General Topology, Dover, 2004.

INTEGRAL TRANSFORMS AND THEIR APPLICATIONS (4 CREDITS- 60 HOURS)

Course Objectives:

1 To learn and understand Laplace and Hankel transforms with properties and Applications.

2 To learn and understand Mellin and Z transform with properties and Applications

Course Outcome	
CO 1	To study about Laplace transform and Inverse Laplace transform
CO 2	To study about Applications of Laplace transform
CO 3	To study Hankel transform with properties and to solve the PDE
CO 4	To study Mellin transform with properties and to solve the summation series
CO 5	To study and understand about Z- transform with properties and to apply for solving the difference equations

Unit I: Laplace Transforms (Sections-3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8)
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.

Unit II: Applications of Laplace Transforms (Sections-4.1, 4.2, 4.3)
Applications of Laplace Transforms to the Solutions of Ordinary Differential Equations, Partial Differential Equations, Initial and Boundary Value Problems.

Unit III: Hankel Transforms (Sections-7.1, 7.2, 7.3, 7.4)
Introduction, The Hankel Transform and Examples, Operational Properties of the Hankel Transform, Applications of Hankel Transforms to Partial Differential Equations.

Unit IV: Mellin Transforms (Sections- 8.1, 8.2, 8.3, 8.4, 8.6)
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.

Unit V: Z Transforms (Sections-12.1, 12.2, 12.3, 12.4, 12.5, 12.6)
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.

Text Book

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.

Reference Books:

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.

MINOR STREAM - I
MINOR – 1 : STATISTICS-I – 4 CREDITS (60 HOURS)

Course Objectives

* To introduce the basic concepts of probability and statistics, including sample spaces, events, probability rules, random variables, and probability distributions.
* To develop an understanding of the mathematical foundations of probability and statistics, such as expectation, variance, and covariance.
* To apply probability and statistics to solve problems in a variety of contexts, such as business, engineering, and science.

Unit I: (Chapter 3 – 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13)
Theory of Probability - I – Mathematical and Statistical Probability, Axiomatic approach to Probability – Some theorems on probability– Simple problems
Unit II: (Chapter 4 – 4.1, 4.2, 4.3)
Theory of Probability – II : Extended axiom of addition and axiom of continuity – Bayes' theorem – Geometric probability - Simple problems.
Unit III: (Chapter 5 – 5.1, 5.2, 5.3, 5.4, 5.5)
Distribution function – Discrete random variable – Continuous random variable – Two dimensional random variable – Simple problems.
Unit IV: (Chapter 6 - 6.1, 6.2, 6.3, 6.4, 6.5, 6.6)
Mathematical Expectation : Mathematical expectation or expected value of a random variable – expected value of function of a random variable – Properties of expectation – Properties of variance – Covariance – Simple problems.
Unit V: (Chapter 8 – 8.1, 8.2, 8.3, 8.4, 8.5, 8.7)
Special Discrete Probability Distributions : Discrete uniform distribution – Bernoulli distribution – Binomial distribution – Poisson distribution – Geometric distribution -

Text Book: S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,12th Edition ,2022

Reference Books:
1. S.P. Gupta, Statistical methods- Sultan Chand and Sons, 45th Edition 2017
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR -2 : STATISTICS-II – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the normal distribution and its properties.
- To develop an understanding of the special continuous probability distributions.
- To introduce the concept of correlation and its measurement.
- To develop an understanding of the linear and curvilinear regression models.
- To introduce the concepts of theory of attributes and its applications.

Unit I: (Chapter 9 – 9.1, 9.2, 9.2.1, 9.2.2, 9.2.3, 9.2.5, 9.2.6, 9.2.7)
Normal Distribution: Limiting form of binomial distribution – Characteristics – Mode – Median – Moment Generating function – Cumulant Generating Function – Moments of Normal distribution

Unit – II: (Chapter 9 – 9.3, 9.3.1, 9.3.2, 9.3.3, 9.3.4, 9.4, 9.5, 9.5.1, 9.5.2, 9.5.3)
Special Continuous Probability Distributions: Rectangular Distribution - Triangular distribution – Gamma Distribution – simple problems.

Unit III: (Chapter 10 – 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7)
Correlation: Meaning of correlation – scatter diagram – Karl pearson's coefficient of correlation – Calculation of the correlation coefficient for a bivariate frequency distribution – Probable error of correlation coefficient – Rank correlation – Simple problems.

Unit IV: (Chapter 11 – 11.4)
Linear and Curvilinear Regression : Linear regression – Curvilinear regression - Regression curves – simple problems

Unit V: (Chapter 13 – 13.13.7)
Theory of Attributes: Notations – Dichotomy – Classes and Class frequencies – Consistency of data – Independence of attributes – Association of attributes - Simple problems.

Text Book: S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014

Reference Books:

1. S.P. Gupta, Statistical methods- Sultan Chand and Sons, 45th Edition 2017
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR -3 : STATISTICS-III – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the concepts of sampling distribution and estimation.
- To develop an understanding of the different types of sampling methods and their errors.
- To learn how to construct and interpret confidence intervals for population means and proportions.
- To learn how to test hypotheses about population means and proportions using large and small sample theory.
- To introduce the concepts of experimental design and its applications.

Unit I: (Chapter 2 – 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8)

Sampling Distribution and Estimation: Introduction – types of sampling methods – sampling and non sampling errors – sampling distribution of mean , difference between two means, proportion, difference between two proportions – Central limit theorem – simple problems

Unit II: (Chapter 2 – 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 2.16)

Sampling Distribution and Estimation: Estimation – confidence interval for the population mean for large samples (when σ is known) , for small samples (when σ is unknown) – for the difference between two population means for large samples (when σ is known) , for the difference between two population means for small samples (when σ is unknown) – confidence interval for the difference between two population proportions for large samples – determining the sample size(using confidence interval)

Unit III: (Chapter 3 – 3.1, 3.2, 3.3, 3.4, 3.5, 3.6)

Tests of Hypothesis: test of significance for large sampling theory – Testing of hypothesis about a population proportion – about the difference between two proportions – about population mean – about difference between two means – difference between two standard deviations

Unit IV: (Chapter 3 – 3.7, 3.8, 3.9, 3.10, 3.11)

Tests of Hypothesis: Test of significance for small sampling theory – about the mean population – about the difference between two means(Using t – test) – Paired t – test for difference of means – testing of hypothesis for equality of two variances

Unit V: (Chapter 3 – 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 3.19)

Tests of Hypothesis: Chi- square distribution - χ^2 Test of Goodness of Fit - χ^2 test of independence of attributes - χ^2 test for population variance – designs of experiments – Completely Randomized (CRD) or One-way Classification – Randomised block design (RBD) or Two way classification – Latin square design (LSD)

Text Book: K. Subramani & A. Santha, Statistics for Management, Second Edition 2011

Reference Books:

1. S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014

2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 201

MINOR -4 : STATISTICS-IV – 4 CREDITS (60 HOURS)

Course Objectives

- To introduce the F-test and its applications.
- To develop an understanding of the Analysis of Variance (ANOVA) technique and its applications.
- To introduce the concepts of statistical quality control and total quality management.
- To develop an understanding of the methods of measuring fertility and mortality, and to learn how to construct life tables.
- To introduce the concepts of time series analysis and index numbers, and to learn how to construct and interpret these measures.

Unit I: (Chapter 5)
F – Test and Analysis of variance: The F- test or the Variance ratio test – Applications of F-test – Analysis of Variance(ANOVA) – Assumptions in ANOVA – Technique of ANOVA – ANOVA in Two – way classification model

Unit II: (Chapter 7)
Statistical Quality Control: Control charts - $\bar{X}$ chart – R chart – Control chart for C – Control chart for P – Advantages and limitations of Statistical quality control – Total quality management – Acceptance sampling

Unit III: (Chapter 16)
Vital Statistics: Introduction – Uses – Methods – Measurement of Fertility – Reproduction rates – Measurement of Mortality – Life tables

Unit IV: (Chapter 5 – 5.2, 5.3, 5.4, 5.5, 5.6)
Time Series Analysis: Time Series analysis – Secular Trend – Measurement of Seasonal variations – Cyclical variations – irregular variations

Unit V: (Chapter 5 – 5.7, 5.8, 5.9, 5.10)
Index Numbers: Characteristics – Uses – Methods of Constructing index numbers – Tests of consistency and adequacy – Cost of living index

Text book:
1. Dr. S.P. Gupta, Statistical methods, Sultan Chand & Sons, 46th Edition, 2021 (Unit I, II, III)
2. K. Subramani & A. Santha, Statistics for Management, Second Edition 2011. (Unit IV, V)

Reference Books:
1. S.C. Gupta & V.K. Kapoor , Fundamentals of Mathematical Statistics- Sultan Chand and Sons,11th Edition ,2014
2. R.S.N.Pillai & V. Bagavathi, Statistics –S.Chand & company LTD, Reprint 2014

MINOR – 5 : OPERATIONS RESEARCH – I – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the field of operations research which has many applications in management techniques.
2. To help students to find optimum solution in business and management problems.

Unit I:

Operations Research –An overview: Introduction – Origin and development of O.R. – Nature and features of O.R. – Applications of Operations Research - Linear programming problem: Mathematical formulation - production allocation problem, product mix problem, product allocation problem only- Graphical solution method - General LPP - Canonical and Standard forms only.

Unit II:

Linear programming problem- Simplex Method : Introduction – The computational procedure –The Simplex Algorithm – Use of Artificial variables -Two Phase method – Big- M method.

Unit III:

Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - Modi method.

Unit IV:

Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.

Unit V:

Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.

Text Book:"Operations Research" by Kanti Swarup, P.K.Gupta and Man Mohan, Sultan Chand & Sons Educational Publishers, New Delhi, 16th Edition 2014.

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

MINOR -6 : OPERATIONS RESEARCH – II – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the various techniques of Operations Research. 2. To make students solve real time problems in Business and management.

UNIT – I :

Sequencing Problem: Introduction –Problem of sequencing – Basic terms used in sequencing –Processing n jobs through two machines –Processing n jobs through k machines.

UNIT – II :

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 .

UNIT- III :

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 .

UNIT IV :

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.

UNIT V :

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):(∞/$FIFO$)}.

Text Books:

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

Reference Books

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

MINOR-7 CALCULUS OF VARIATIONS -(4 CREDITS-60 HOURS)

Course Objectives

1. To learn about functionals and solving related variational problems by Euler's equation
2. To understand and solve the variational problems functionals depending on higher order derivatives

	Course Outcome
CO 1	To study about the general variational of a functional and the Weierstrass Erdmann conditions
CO 2	To study and understand about canonical form of Euler equations and other transformations, Noether's Theorem and conservation laws
CO 3	To learn about second variation and Legendre conditions of a functional

Unit I:

Functionals- some simple variational problems-The variation of a functional- A necessary condition for an extremum-

The simplest variational problem-Euler's equation-The case of several variables-A simple variable end point problem- The variational derivative-Invariance of Euler's equation.*[Chapter-1]*

Unit II:

The fixed end point problem for n-unknown functions - Variational problem in parametric form-Functionals depending on higher order derivatives-Variational problems with subsidiary conditions. *[Chapter-2]*

Unit III:

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]*

Unit IV:

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]*

Unit V:

The second variation of a functional- The formula for the second variation, Legendre conditions-Sufficient conditions for a weak extremum. *[Chapter-5]*

Text Book:

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

Reference Books:

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.

MINOR-8 INTEGRAL EQUATIONS (4 Credits -60 HOURS)

Course Objectives	Description
1	Learn about the classification of integral equations and IVP for ODEs.
2	Explore BVPs for ODEs, elliptic PDEs, and Abel's problem.
3	Investigate the relationship between second-order ODEs and integral equations.
4	Examine integral equations of the second kind, including degenerate kernels.
5	Learn about operators and the Neumann series for solving integral equations.

Course Outcomes	Description
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-I

Introduction - Classification of integral equation - examples - IVP for ODE.

Unit-II

BVP for ODE - BVP for elliptic PDE - Abel's problem.

Unit-III

Second order ODE and integral equations -Differential equation theory - initial value problems - Boundary value problems - Singular boundary value problems.

Unit-IV

Integral equations of the second kind - Introduction - Degenerate kernels - a different approach.

Unit-V

Operators - Newmann series.

Text Book

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

MINOR STREAM II

MINOR -1: MATHEMATICS OF FINANCE – 4 CREDITS (60 HOURS)

UNIT I :

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 installments (EMI) – Problems.

UNIT II :

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 non- homogeneous system of linear equations (not more than three variables) – Conditions for existence and uniqueness of solution – Solution using inverse of the coefficient matrix – Problems.

UNIT III :

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.

(Problems: 80%, Theory: 20%)

Text Books

1. **Kappor, V.K., Business Mathematics, Sultan Chand & Sons, New Delhi**

Books for References:

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. Richard, I. L., Masood, H. S., David, S. R., & Rastogi, S. (2017). Statistics for Management. New Jersey: Pearson Education.
6. Thukral, J. K. (2017). Business Mathematics and Statistics. New Delhi: Maximax Publications.
7. Vohra, N. D. (2014). Business Mathematics and Statistics. New Delhi: Tata McGraw Hill Education India.

MINOR – 2 : BUSINESS STATISTICS– 4 CREDITS (60 HOURS)

UNIT I:

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.

UNIT II: 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.

UNIT III: 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 - CorrelationVs Regression Regression lines and Regression Equations Regression co-efficient- Computation of correlation co-efficient from regression co-efficient.

UNIT IV:

Index Numbers: Definition - Characteristics of Index numbers – Uses - Types of index numbers - Construction of Price Index numbers - Unweighted Index numbers -Weighted Index numbers - Tests of adequacy of Index number - formulae. Chain - basis index number base shifting, splicing, and deflating problems in constructing indexnumbers; Consumer price index.

UNIT V:

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.

Text Books

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 References

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

MINOR -3 : NUMERICAL ANALYSIS – 4 CREDITS (60 HOURS)

UNIT I:

Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.

UNIT II:

Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.

UNIT III:

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.

UNIT IV:

Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.

UNIT V:

Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.

Text book

Numerical Method in Science and Engineering,
M.K.Venkataraman,NationalPublicationCo,Chennai(2001)
Unit1: Chapter 3 and 4
Unit2: Chapter 5
Unit3: Chapter 6 and 9
Unit4:Chapter11(Relevantportions)Unit5:Chapter11(Relevantportions)

ReferenceBooks

ComputerorientedNumerical MethodsbyV.Rajaram–PHI(P)Ltd.

e-LearningSource

http://ndl.iitkgp.ac.in
http://ocw.mit.edu
http://mathforum.org

MINOR -4: OPTIMIZATION TECHNIQUES – I – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the field of operations research which has many applications in management techniques.
2. To help students to find optimum solution in business and management problems.

Unit I:

Operations Research –An overview: Introduction – Origin and development of O.R. – Nature and features of O.R. – Applications of Operations Research - Linear programming problem: Mathematical formulation - production allocation problem, product mix problem, product allocation problem only- Graphical solution method - General LPP - Canonical and Standard forms only.

Unit II:

Linear programming problem- Simplex Method : Introduction – The computational procedure –The Simplex Algorithm – Use of Artificial variables -Two Phase method – Big- M method.

Unit III: Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - Modi method.

Unit IV: Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.

Unit V:

Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.

Text Book: "Operations Research" by Kanti Swarup, P.K.Gupta and Man Mohan, Sultan Chand & Sons Educational Publishers, New Delhi, 16th Edition 2014.

1. Unit I : Chapter 1, 2 & 3 Sections 1.1 to 1.3, 1.10, 2.1 to 2.4, 3.2 to 3.5
2. Unit II : Chapter 4 Sections 4.1, 4.3, 4.4
3. Unit III : Chapter 10 Sections 10.1, 10.2, 10.5, 10.8, 10.9, 10.10, 10.12, 10.13
4. Unit IV : Chapter 11 Sections 11.1 to 11.4
5. Unit V : Chapter 25 Sections 25.1 to 25.6

Reference Book:

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

MINOR -5 : OPTIMIZATION TECHNIQUES – II – 4 CREDITS (60 HOURS)

Objectives:

1. To introduce the various techniques of Operations Research.

2. To make students solve real time problems in Business and management.

UNIT – I :

Sequencing Problem: Introduction –Problem of sequencing – Basic terms used in sequencing –Processing n jobs through two machines –Processing n jobs through k machines.

UNIT – II :

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 .

UNIT- III :

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 .

UNIT IV :

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.

UNIT V :

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):(∞/$FIFO$)}.

Text Books:

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

Reference Books

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

MINOR – 6 : APPLIED STATISTICS– 4 CREDITS (60 HOURS)

Objectives:

1. To learn the basics of statistics concepts
2. To learn solving correlation and regression problems

Outcomes:

1. Ability to understand and represent data
2. Ability to analyze and interpret data.

UNIT I:

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.

UNIT II:

Measures of Central Value: Arithmetic Mean : Calculation of Simple Arithmetic Mean-IndividualObservations,CalculationofArithmeticMean-DiscreteSeries,CalculationofArithmeticMean-ContinuousSeries,MeritsandLimitationsofArithmeticMean.
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,CalculationofMode-ContinuousSeries,MeritsandLimitationsofMode.

UNIT III :

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.

UNIT IV :

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.

UNIT V :

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

TEXTBOOK

S.P.GUPTA, "Statistical Methods", Sultan Chand &Sons, Educational Publishers ,New Delhi,2016

REFERENCEBOOK:

P.R.Vittal, "Mathematical Statistics",Margham Publications, 2016

MINOR STREAM – III

MINOR -1 : MATRICES AND TRIGONOMETRY – 4 CREDITS (60 HOURS)

Unit 1:
Martrices – rank of Matrices – Consistency of a system of linear non –homogeneous equations (statement only) – simple problems

Unit 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

Unit 3:
De Moivre's theorem and its applications – Direct and Inverse circular and hyperbolic functions.

Unit 4:
Logarithm of a complex quantity- Expansion of Trigonometrical functions

Unit 5:
Gregory's series- Summation of series.

Text book:

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)***

MINOR -2 : CALCULUS – 4 CREDITS (60 HOURS)

UNIT I :
nth derivative – Standard results – Trigonometrical transformation – Formation of equations involving derivatives – Leibnitz formula

UNIT II :
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

UNIT- III :
Circle, radius and centre of curvature – Cartesian formula for radius of curvature – envelope

UNIT- IV:
Integration of rational algebraic functions – Integration of irrational algebraic functions - Properties of definite integrals

UNIT- V:
Integration by parts – reduction formula, Bernoulli's formula - Evaluation of double integral (Cartesian form only) – Triple integral (Cartesian form only)

Textbook

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
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,

Reference books

1. Integral Calculus, N. P. Bali, Laxmi Publications, Delhi, (1991)
2. 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.

MINOR -3 : VECTOR CALCULUS – 4 CREDITS (60 HOURS)

Objective:
To attain the basic knowledge on vector calculus.

UNIT I :
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.

UNIT II :
Divergence and curl - Formula involving operator, operators involving twice – Simple problems.

UNIT III:
Vector integration - Line integral – Surface integral – Volume integral – Simple problems.

UNIT IV :
Gauss divergence theorem – Green's theorem (in space) (Statement only) – Simple problems using theorems.

UNIT V :
Stoke's theorem - Green's theorem (in plane) (Statement only) – Simple problems using theorems. #

Text Book:

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).

MINOR -4 : INTRODUCTION TO DIFFERENTIAL EQUATIONS – 4 CREDITS (60 HOURS)

Ordinary differential equations

Unit 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 a differential equations – orthogonal trajectories.

Unit 2:

Linear Differential equations with constant coefficients – Homogenous linear ordinary differential equation – linear differential simultaneous differential equations.

Partial differential equations

Unit 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 – Lagranges method of solving the linear equation Pp+Qq=R

Unit 4 :

Charpits method - Linear Partial Differential equation of second and higher order with constant coefficients.

Unit 5 :

Boundary value problems method of separation of variable transverse vibrations of string – the one dimensional heat flow equations a Cartesian form.

Text books

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**

Reference Books

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

http://ndl.iitkgp.ac.in/
http://ocw.mit.edu/
http://mathforum.org/

MINOR -5 : FOURIER SERIES AND LAPLACE TRANSFORMS – 4 CREDITS (60 HOURS)

UNIT 1:

Dirichlet's condition general Fourier series Odd and Even Functions half range Sine series and Half range cosine series.

UNIT 2:

Complex form of Fourier series Parseval's Identity.

UNIT 3:

Transform of the equation by changing the dependent variables / the independent variables – Method of variations of parameters – ordinary simultaneous differential equations.

UNIT 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 $e^{-a} f(t)$ 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.

UNIT 5:

Application to solution of ordinary differential equation with constant coefficients – involving the above transforms.

Text books

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)**

Reference Books

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

MINOR -6 : NUMERICAL ANALYSIS – 4 CREDITS (60 HOURS)

UNIT I:

Numerical solution of algebraic and transcendental equations – Bolzano's bisection method - Successive approximation method – Regula falsi method – Newton-Raphson method.

UNIT II:

Numerical solution of simultaneous linear algebraic equations – Gauss elimination method - Gauss Jordan elimination method – Gauss Seidel iteration method.

UNIT III:

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.

UNIT IV:

Numerical solutions of Ordinary differential equations of first and second order – Simultaneous equations – Taylor series method – Picard's method.

UNIT V:

Euler's method – Improved Euler's Method - Modified Euler's Method – Runge-Kutta method of second and fourth order – Milne's predictor corrector method.

Text book

Numerical Method in Science and Engineering, M.K. Venkataraman, National Publication Co, Chennai(2001)
Unit1: Chapter 3 and 4
Unit2: Chapter 5
Unit3: Chapter 6 and 9
Unit4:Chapter11(Relevantportions)Unit5:Chapter11(Relevantportions)

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

http://ndl.iitkgp.ac.in
http://ocw.mit.edu

http://mathforum.org

SKILL ENHANCEMENT COURSES

SEC-1 : QUANTITATIVE APTITUDE - 3 CREDITS (48 HOURS)

Unit 1: Fundamentals of Arithmetic

This unit focuses on the foundational principles of arithmetic, covering the Number System, including various types of numbers, their properties, and operations. It also explores the computation of the Highest Common Factor (H.C.F.) and the Least Common Multiple (L.C.M.) of numbers, along with Decimal Fractions.

Unit 2: Basic Mathematical Operations

Unit 2 is dedicated to essential mathematical operations, including Simplification techniques, efficient methods for calculating Square Roots and Cube Roots, and a comprehensive understanding of Averages.

Unit 3: Problem Solving

Unit 3 enhances problem-solving skills by addressing a wide range of numerical problems, including Problems on Numbers, Problems on Ages, and Surds and Indices.

Unit 4: Advanced Arithmetic

Unit 4 introduces more advanced arithmetic concepts, such as Logarithms, Percentage calculations, and the principles of Profit and Loss.

Unit 5: Review and Application

The final unit, Unit 5, provides an opportunity to review and apply the knowledge gained in previous units. It covers Ratio and Proportion, Partnership, and the Chain Rule for interconnected problem-solving.

Textbook References:

1. Quantitative Aptitude by R.S. Agarwal
2. Quantitative Aptitude by Abhijit Guha

SEC 2: LOGICAL REASONING - 3 CREDITS (48 HOURS)

Course Description:

Logical Reasoning-I is designed to develop students' logical thinking and problem-solving abilities through various topics. This course focuses on enhancing critical thinking and decision-making skills.

Course Outcomes: By the end of this course, students will be able to:

1. Analyze and complete various series patterns.
2. Apply analogical reasoning to identify and complete analogous pairs.
3. Classify objects and identify odd ones out based on given criteria.
4. Decode and encode messages using various coding techniques.
5. Solve puzzles and problems related to blood relations and directional sense.
6. Apply principles of number, ranking, and time sequence tests, along with arithmetical reasoning and mathematical operations.

Unit 1: Series Completion

This unit covers Number Series, Alphabet Series, and Alpha-Numeric Series. Students will learn to identify and complete various series patterns.

Unit 2: Analogy

Unit 2 explores Completing the Analogous Pair, Simple Analogy, Choosing the Analogous pair, Double Analogy, Word Analogy, and Number Analogy.

Unit 3: Classification / Odd One Out

This unit involves Word Classification, Number Classification, and Letter Classification, helping students identify patterns and outliers.

Unit 4: Coding – Decoding

Unit 4 introduces Letter Coding, Number Coding, Matrix Coding, Substitution, Deciphering Message Word Codes, and Jumbled Coding, enhancing code-based problem-solving skills.

Unit 5: Blood Relations

Unit 5 focuses on deciphering Jumbled up Descriptions and solving Relation Puzzles, including Direction Sense Tests.

Unit 6: Number, Ranking & Time Sequence Test

Unit 6 covers Number, Ranking & Time Sequence Tests, Arithmetical Reasoning, and Mathematical Operations.

Textbook Reference: "Verbal and Non-Verbal Reasoning" by R.S. Agarwal

SEC 3: LATEX 3 CREDITS (48 HOURS)

Course Outcomes:

By the end of this course, students will:

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

Unit 1: Introduction to LaTeX (Based on Preface and Chapter 1)

Should You Be Reading This Book?, Motivation for Learning LaTeX, Running LaTeX, Resources for LaTeX

Unit 2: Basic LaTeX (Based on Chapter 2)

Sample Document and Key Concepts, Type Style in LaTeX, LaTeX Environments: Lists, Centering, Tables, Verbatim, Managing Vertical and Horizontal Spacing

Unit 3: Typesetting Mathematics (Based on Chapter 3)

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

Unit 4: Further Essential LaTeX (Based on Chapter 4)

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

Unit 5: More About LaTeX (Based on Chapter 5)

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.

Reference Book: "Learning LaTeX" by David F. Griffiths and Desmond J. Higham

MULTI-DISCIPLINARY COURSE:

MLDC BASIC MATHEMATICS (3 CREDITS- 4hrs) -48 hrs

Course Objectives	Description
1	Learn linear systems, matrices, dot product, and matrix transformations.
2	Solve linear systems using row echelon forms, polynomial interpolation, and matrix inversion.
3	Understand logic, truth tables, algebra of propositions, and set operations.
4	Apply principles of inclusion-exclusion, addition/multiplication rules, and pigeonhole principles.
5	Learn permutations, combinations, and elementary probability.

Course Outcomes	Description
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 I:

Linear System – Matrices – dot Product – Matrix multiplication – properties of Matrix operations – Matrix transformation.

Unit II:

Solution of linear system of equations – row echelon form – reduced row echelon form – Polynomial interpolation – inverse of a matrix – linear systems.

Unit III:

Logic – truth table – algebra of propositions- logical arguments – sets- operations on sets.

Unit IV:

Principle of inclusion – exclusion – the addition and multiplication rules – pigeonhole principles.

Unit V:

Permutations – Combinations – Elementary Probability.

Text Book:

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