Swami Ramanand Teerth Marathwada University, Nanded
School of Mathematical Sciences

Two Year M. A. / M. Sc. Degree Program in Mathematics

Revised Syllabi of M. A. / M. Sc. in Mathematics

(Choice Based Credit System)

(To be implemented in the Department of Mathematics, Swami Ramanand Teerth Marathwada University, Nanded)

(With effect from Academic Year 2016-2017)

Title of the Program: M. A. / M. Sc. in Mathematics

1. Preamble: M. A. / M. Sc. Mathematics programme is of minimum 100 credits spread over four semesters. The programme emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, a large number of elective courses, extensive computer training including standard software packages such as MATLAB, SciLab and TORA. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. The syllabus of the first year (two semesters) covers most of the core courses. In the third semester syllabus there are two core courses and eight elective courses. In the fourth semester syllabus there are two core courses and fourteen elective courses. The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics.

It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives.

2. Introduction: M. A. / M. Sc. Mathematics program has semester pattern and credit system with variable credits. The program consists of 100 credits. Credits of a course are specified against the title of the course. A course with T in brackets indicates that it is a theory course whereas a course with P in brackets indicates that it is a practical course. Some of the practical courses are linked with a theory course and in such a case, both the courses will have the same number with T and P, indicating a theory and a practical course respectively. A student can enroll for a practical course if the student has enrolled for the corresponding theory course (as indicated) in the same term.

- **Scope:** Mathematics is at the heart of science, engineering and technology, as well as being an indispensable problem-solving and decision-making tool in many other areas of life. Mathematics has got a great importance in the industrial and economic development of a country. M.Sc. in Mathematics is the postgraduate course in Mathematics which enables the candidates to use their mathematical knowledge in different areas. This course has got great scope and there are ample opportunities available for the M.Sc. graduates.

The scope of opportunities is vast and mathematics postgraduates are equipped

with skills and knowledge required for jobs in fields such as finance, education, engineering, science and business, as well as mathematics and mathematical science research.

3. The key learning outcomes of the M.Sc. Mathematics are:

• The students may get wide range of opportunities of Mathematics in industry sector.

• The students will get wide range of Mathematical skills, including problem-solving, project work and presentation; they may enable to take prominent roles in a wide spectrum of employment in academics and research.

- The fundamental and advanced concepts, principles and techniques from a range of topic areas.
- Specific knowledge and understanding will be determined by your particular choice of modules, according to your particular needs and interests.
- Understand complex mathematical ideas and arguments.
- Develop abstract mathematical thinking.

4. Eligibility: For M. A/ M.Sc. in Mathematics following candidates are eligible.

- B.A./B.Sc. with Mathematics as principal Subject at degree level.

5. Definitions:

Credits:

Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 15 contact hours.

- In each of the courses, credits will be assigned on the basis of the number of lectures / tutorials / laboratory work and other forms of learning required for completing the course contents in maximum 18 week schedule.
- The instructional days as worked out by the UGC for one academic year are 180 working days i.e. 90 days per semester.
- **Mechanics of Credit Calculation:** As per SRTMUN standard, 1Credit= 15 contact hours. o Contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / fieldwork or other forms which suits to that particular course. In determining the number of hours of instruction required for a course involving laboratory / field-work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture.

Credit Point (P):
Credit point is the value obtained by multiplying the grade point (G) by the credit (C): P = G x C.

Grade Point:
Grade point is an integer indicating the numerical *SEMESTER GRADE POINT AVERAGE (SGPA):*
II. Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

II. Cumulative Grade Point Average (CGPA):

'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicate an overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his/her CGPA. The comprehensive academic performance of a student in a programme is equivalent of the letter grade.

- **Evaluation System -**

In this section the broad guidelines to be followed in evaluation system and the minimum number of credits to be completed to get a degree are defined.

- The evaluation will be on Continuous Internal Assessment (CIA), End Semester Assessment (ESA). The final results shall be declared after integration of CIA and ESA
- Weightage: 50% for End Semester Assessment (ESA) & 50% for Continuous Internal Assessment (CIA)

The declaration of result is based on the grade point average (GPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned towards the end of the program.

a) The Post-graduate degree will be awarded to those students who earn the minimum number of Credits. For the award of degree the student has to acquire minimum number of credits as per the table given below.

Name of the Faculty/course	Total credits	Average credits per semester
M.A./ M.Sc.	100	25

b) One credit will be equivalent to 15 clock hours of teacher-student contact in a semester.

c) Four –credit course of theory will be of four clock hours per week.

d) Two- credit course of practical will be of 4 hours of lab exercise/field.

e) The project / Dissertation will be commencing from Semester III and the final work & report will be completed during Semester IV. The marks & the credits will be allotted in semester IV.

f) There will be no mid-way change allowed from Credit System to Non-credit (external) System or vice versa.

g) In a case, where the PG program duration is of one year, such a program shall consist of minimum 50 credits. Certificate programs shall consist of 25 credits/ semester.

h) In a case, where the PG program duration is of three year, such a program shall consist of minimum 150 credits.

i) Except the credits for practical courses, wherever applicable, a student can register for less number of courses in a semester subject to the condition that such a student will have to complete the degree in a maximum of five, four and two years respectively for three, two and one year programs. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 25 % credits (in case of fresh credits) per semester.

j) CBCS: Among the minimum number of credits to be earned by a student to complete a Post Graduate degree program (100/64 credits), the student will have to earn minimum 75% credits from the core subjects and the remaining 25 % credits could be earned from the elective/ open elective (inter/intra disciplinary and soft skills) subjects offered within and across the schools. The maximum number of credits offered across the disciplinary (including soft skills) should not exceed 10% of total credits for the program.

k) Credit transfer from other Institutes: Depending on the feasibility and availability a maximum of four credits can be completed by the student in any of the national or reputed institutes/organizations/companies/ industries (HOST). For this a student has to complete a minimum number of 15 interactive hours (not necessarily only teaching) with assigned faculty from Host. It may be 3-4 interactive hours in a day and the

necessary certificate in this regard shall be issued by HOST faculty. The Director of the school can fix this credit transfer mechanism with mutual consent/understanding form any host institute. After completion of minimum required interactive/teaching hours at the chosen institute the Host has to provide course completion certificate with a grade. The assessment will be made by the concerned faculty of the host and one faculty/Director of the concerned school (Parent) and performance grade and marks will be allotted. The same marks shall be sent to university examination section along with other marks for declaration of the results by the concerned school.

6. **Examination/Evaluation Rules**

The evaluation of the student will be mainly on

1. **Continuous Internal Assessment (CIA) and**
2. **End Semester Assessment (ESA).**

The ratio of CIA and ESA is 50:50

Passing Rules:

The CIA and ESA shall have different passing heads and Minimum passing:- 40% of passing for each subject in each head. To pass the degree program, a student will have to obtain a minimum aggregate of 40% marks (C+ and above in grade point scale) in each course.

Assessment:

Continuous Internal Assessment (CIA):

CIA aims to assess values, skills and knowledge imbibed by students, internal assessment is to be done by the concerned faculty member, department, school or the centre. **CIA** will be done on a continuous basis during the semester with selected assessment components.

The components selected for CIA may be:

Tests, Quiz, Seminars, Assignments, essay, tutorials, term paper, seminar, laboratory work, field work, workshop practice, Comprehensive Viva, Attendance and any other best and innovative assessment practice approved by the School committee. Components of internal evaluation are to have a time frame for completion (by students), and concurrent and continuous evaluation (by faculty members).

The evaluation outcome shall be expressed initially by predetermined marks and latter converted by grades. Minimum Mark for passing in each Paper is 40% for Continuous Internal Assessment **(CIA)**

End Semester Assessment (ESA): This is to be carried out at the end of each semester, and will aim to assess skills and knowledge acquired by the students through classroom instruction, fieldwork, laboratory work and/or workshop practice. The End Semester Assessment (ESA) is based on written examination. These examinations shall be at the end of each semester.

Integration of CIA and ESA: A student failed in CIA shall have to appear for ESA again in that particular paper. In a particular paper if a student failed in internal (CIA), he deemed to be failed in that course and he has to reappear for CIA and ESA irrespective of the marks he got in ESA. If a student passed in CIA and failed in ESA, the student needs to appear for ESA only in his next attempt and the CIA marks shall be carried.

A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations to be held in winter/summer season. However the student has to clear the course in the prescribed maximum period for that course.

CIA marks will not change. A student cannot repeat CIA. In case s/he wants to repeat CIA, then s/he can do so only by registering the said course during the semester in which the course is conducted and up to 4 years (2 years program) as the case may be, provided the student was failed in that course. Students who have failed in a course may reappear for the ESA only twice in the subsequent period. If student fail to acquire required Credits within four years from admission period, such student has to acquire Credits with prevailing / revised syllabus at that time. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

A student cannot register for the third/fourth semester, if she/he fails to complete 75% credits of the total credits expected to be ordinarily completed within two semesters.

While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points).

7. Assessment and Grade point average:

7.1 The system of evaluation will be as follows: Each CIA and ESA will be evaluated in terms of marks. The marks for CIA and ESA will be added together and then converted into a grade and later a grade point average.

7.2 Results will be declared for each semester.

7.3 After the completion of minimum number of credits of a program, a student will get a grade sheet with total grades earned and a grade point average.

7.4 Marks/Grade/Grade Point:

i) Table 1: Conversion of marks to grades in credit system

Marks Obtained	Grade	Grade Points
100-90	S	10
89-80	O	09
79-70	A+	08
69-60	A	07
59-55	B+	06
54-45	B	05
44-40	C+	04
39 and Less FC	FC	0 (Fail but Continue)
39 and Less (Internal)	FR	0 (Fail and Repeat the course)

ii) A student who passes the internal tests but fails in Term End Examination of a course shall be given FC grade. Student with FC grade in a course would be granted credit for that course but not the grade for that course and shall have to clear the concerned course within 1.5 year from appearing for first time in the concerned paper, provided the number of courses with FC and FR grades together is 25% or less of the courses of that semester, failing which he/she shall be disqualified for a credit and will have to opt for another credit.

iii) Student who has failed in the internal tests of a course shall be given FR grade and shall have to repeat the concerned course to qualify to appear for term end examination of that course. The grade FC and FR will be taken into consideration while calculating Semester Performance Index (SPI). It shall be replaced only when student clears the course with passing grade within 1.5 year from appearing for first time in the concerned semester.

iv) Grade points earned in each paper shall be calculated as- Grade points obtained (vide Table 1 above) X Credits for the paper.

Maximum grade points that can be earned in a semester are 200.

v) The Semester Performance Index (SPI) gives weighted performance index of a semester with reference to the credits of a course. The SPI shall be calculated as-

SPI = Total Earned Grade Pointes (as given above) for the Semester
Total Credits for the semester

7.5 The total grade point earned in each course shall be calculated as:
Grade point obtained as shown in table -1 **X** Credits for the Course

7.6 Semester Grade Point Average (SGPA): The performance of the student in a semester is indicated by number called SGPA. It shall be calculated as follows:

$$\text{SGPA} = \frac{\sum_{i=1}^{n} c_i p_i}{\sum_{i=1}^{n} c_i}$$

Where C_i = The number of Credits earned in the i^{th} course of a semester for which SGPA is to be calculated.

p_i = Grade point earned in the i^{th} course.

i = 1,2,3,4,……..n represent the number of courses in which a student is registered in the concerned semester.

That is

$$\text{SGPA} = \frac{\text{Total earned grade point for the semester}}{\text{Total credits for the semester}}$$

7.7 Final result:

The final marls after assessment will be submitted by the respective schools to the controller of Examination for finalization of the resuts. Up to date assessment of the overall performance of a student from the time of his / her first registration is obtained by calculating a number is called as Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all courses registered by the student since he / she entered the department.

$$\text{CGPA} = \frac{\sum_{j=1}^{m} c_j p_j}{\sum_{j=1}^{m} c_j}$$

Where C_j = The number of Credits earned in the j^{th} course up to the semester for which CGPA is to be calculated.

p_j = Grade point earned in the j^{th} course.

j = 1, 2, 3, 4…m represent the number of courses in which a student is registered up to the semester for which the CGPA is to be calculated.

- **Final Grade: Table -2**

CGPA	Grade
09.00-10.00	S: Super
08.00-08.99	O : Outstanding
07.50-07.99	A+: Excellent
07.00-07.49	A: Very Good
06.00-06.99	B+: Good
05.00-05.99	B: Satisfactory
04.00 -04.49	C+: Pass
00.00-03.99	F: Fail

7.8 'B+' Grade is equivalent to at least 55% of the marks as per circular No. UGC- 1298/ [4619] UNI- 4 dated December 11, 1999.

7.9 " A" Grade is equivalent to first class

7.10 If the (C) GPA is higher than the indicated upper limit in the three decimal digit, then higher final grade will be awarded (e.g. a student getting (C)GPA of 3.992 may be awarded 'C+' grade).

7.11 For grade improvement a student has to reappear for End Semester Examination (ESE) after the successful completion of the course for a minimum 20 credits in case of Science, Technology, Management and Pharmacy, 20 credits for other faculties and 12 credits in case of one year degree program. These courses will be from the parent Department (core subject). A student can appear only once for the Grade Improvement Program only after the successful completion of UG / PG Degree program and at the end of the next academic year after completion of the Degree and within two years of completion of the Degree.

7.12 The formula for CGPA will be based on Weighted Average. The final CGPA will not be printed unless a student earns minimum 100 credits, 80 credits or 64 credits, as the case may be, from the courses at UG / PG programs.

7.13 If a student failed to obtain a grade other than F in a course then such a course will not be taken into account for calculating CGPA and overall grade. In fact, all the courses in which a student has passed will be taken into account for calculating the CGPA and overall grade.

8. Norms & Procedure for Extra Credit Benefit for NSS or Participation:

The following table shows the grades along with grade point to be given to the students participating in the NSS / Sports activities:

The student should avail the only one benefit neither from NSS or Sport activities.

Maximum addition of Grade point = 0.200

Sr. No.	Event	Specification	Grade point
1	NSS Performance	2 Year regular Programme [240 hrs work + Blood donation + Camp (State / National Level)]	0.200
2	Sports Performance	Intercollegiate : I /II /III	0.150
		Inter- University : I /II /III or Participation	0.200

8. Structure of the course

M.Sc. Mathematics (CBCS Pattern)

SEMESTER-I								
Sr. No.	**Course**	**Course Title**	**Theory / Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
MTU-101	Core I	Group Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-102	Core II	Real Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-103	Core III	Complex Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-104	Core IV	Ordinary Differential Equations	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-105	Elective	Advanced Discrete Mathematics	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-106	Elective	Probability and Statistics	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-107	Practical I	Latex Typesetting	**p**	**2**	**50**	**25**	**25**	**50**
MTU-108	Practical II	Writing and presentation using LaTeX	**p**	**2**	**50**	**25**	**25**	**50**
MTU-109	Soft Skill	Soft Skill-I	**L/T/P**	**1**	**25**	**--**	**25**	**25**
		Total						**625**

SEMESTER-II								
Sr. No.	**Course**	**Course Title**	**Theory / Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
MTU-201	Core I	Linear Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-202	Core II	Measure and Integration	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-203	Core III	Topology	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-204	Core IV	Partial Differential Equations	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-205	Elective	Elementary Number Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-206	Elective	Graph Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-207	Practical III	Programming in Scilab	**p**	**2**	**50**	**25**	**25**	**50**
MTU-208	Practical IV	Mathematical tools in SciLab	**p**	**2**	**50**	**25**	**25**	**50**
MTU-209	Soft Skill	Soft Skill-II	**L/T/P**	**1**	**25**	**--**	**25**	**25**
		Total						**625**

SEMESTER-III								
Sr. No.	**Course**	**Course Title**	**Theory/ Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
MTU-301	Core I	Galois Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-302	Core II	Functional Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
Elective Group III (MTU 303 to MTU 311- any three)								
MTU-303	Elective	Fractional Calculus	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-304	Elective	Operations Research	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-305	Elective	Analytic Number Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-306	Elective	Lattice Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-307	Elective	Coding Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-308	Elective	Riemannian Geometry	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-309	Elective	Algebraic Topology	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-310	Elective	Representation Theory of Finite Groups	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-311	Elective	Difference Equations	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-312	Practical III	Programming in C	**p**	**2**	**50**	**25**	**25**	**50**
MTU-313	Practical IV	Methods in Numerical Analysis using C	**p**	**2**	**50**	**25**	**25**	**50**
MTU-314	Seminar	Seminar-I	**L/T/P**	**1**	**25**	**--**	**25**	**25**
		Total						**625**

SEMESTER-IV								
Sr. No.	**Course**	**Course Title**	**Theory/ Practical Paper**	**No. of Credits**	**Marks@ 25/Credit**	**Internal Component (50%)**	**Semester End Component (50%)**	**Grand Total**
MTU-401	Core I	Commutative Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-402	Core II	Integral Equations and transforms	**L/T**	**4**	**100**	**50**	**50**	**100**
Elective Group III (MTU 403 to MTU 410- any three)								
MTU-403	Elective	Lie Groups and Lie Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-404	Elective	Algorithms and their analysis.	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-405	Elective	Algebraic Geometry	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-406	Elective	Classical Mechanics	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-407	Elective	Theory of Relativity	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-408	Elective	Cryptography	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-409	Elective	Algebraic Number Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-410	Elective	Fuzzy sets and their applications	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-411	Elective	Multivariate Calculus	**L/T**	**4**	**100**	**50**	**50**	**100**
MTU-412	Core Project	Project Work	**p**	**4**	**100**	**50**	**50**	**100**
MTU-413	Seminar	Seminar-II	**L/T/P**	**1**	**25**	**--**	**25**	**25**
		Total						**625**

List of Core/ Elective Subjects to be offered

Core Subjects

1. Group Theory
2. Real Analysis
3. Complex Analysis
4. Linear Algebra
5. Real Analysis-II
6. Topology
7. Galois Theory
8. Functional Analysis
9. Commutative Algebra
10. Integral Equations and transforms
11. Latex Typesetting
12. Writing and Presentation using LaTeX
13. Programming in Scilab
14. Mathematical tools in SciLab
15. Programming in C
16. Methods in Numerical Analysis using C
17. Soft Skill-I
18. Soft Skill-II
19. Seminar-I
20. Seminar-II
21. Project Work

Elective Subjects

Elective Group I (Any one for First Semester)

1. Advanced Discrete Mathematics
2. Probability and Statistics

Elective Group II (Any one for Second Semester)

1. Elementary Number Theory
2. Graph Theory

Elective Group III (Any three for Third Semester)

1. Fractional Calculus
2. Operations Research
3. Analytic Number Theory
4. Lattice Theory
5. Coding Theory
6. Riemannian Geometry
7. Algebraic Topology
8. Representation Theory of Finite Groups
9. Difference Equations

Elective Group IV (Any three for Fourth Semester)

1. Lie Groups and Lie Algebra
2. Algorithms and their analysis.
3. Algebraic Geometry
4. Classical Mechanics

5. Theory of Relativity
6. Cryptography
7. Algebraic Number Theory
8. Fuzzy sets and their applications
9. Multivariate Calculus

NOTE:

- Each semester will have five Theory papers and each theory paper will be of 100 Marks [50 External Exam+ 50 Internal Exam (02 tests each of 15 Marks+20 Marks for class performance)].
- Each Practical course will be of 50 marks [25 External Exam + 25 Internal Exam (1 test of 15 marks+ 10 marks for class performance)].
- Each Soft Skill and Seminar course will be of 25 marks [External Exam].
- All the Practical, Soft Skill and Seminar courses are compulsory to all the students.
- Each semester is of 625 marks.
- Total marks for I sem+ II sem+ III sem + IV sem = 2500.
- Total degree is of 2500 Marks, converted in the form of 100 credits CBCS system.
- One credit is of 25 marks.
- Minimum 40% Marks are required for passing in each of the above head i.e. separate passing in External Exam and that in Internal Exam.
- Project/ Practical will be evaluated by one external examiner and one internal examiner.
- Project work will be commencing from Semester III and the final work & report will be completed during Semester IV. The marks & the credits will be allotted in semester IV.

Semester-I

MTU- 101: Group Theory

Prerequisites: Introduction to Groups, Definition and Examples, Elementary properties of Groups, Finite Groups and Subgroups, Subgroup Tests, Examples of Subgroups).

Unit I: Cyclic Groups, Properties of Cyclic Groups, Classification of Subgroups of Cyclic Groups, Permutation Groups, Definition and Notation, Cycle Notation, Properties of Permutations, A Check-Digit Scheme Based on D5. **(12L+3T)**

Unit II: Isomorphisms, Definition and Examples, Cayley's Theorem, Properties of Isomorphisms, Automorphisms, Cosets and Lagrange's Theorem, An Application of Cosets to Permutaion Groups, External direct products, Normal Subgroups, Factor Groups, Application of Factor Groups.

Unit III: Conjugacy and G-sets: Group action, G-set and examples, orbit of an element and their properties, Conjugates. Normal series, Solvable groups and Nilpotent groups. **(12L+3T)**

Unit IV: Internal Direct Product, Group Homomorphisms and their properties, The First Isomorphism Theorem, The Fundamental Theorem, Isomorphism Classes of Abelian Groups, Proof of Fundamental Theorem, The Class Equation, The Sylow Theorem. **(12L+3T)**

Text Books:

1. J. A. Gallian, Contemporary Abstract Algebra, Fourth edition, Narosa Publishing House.

Scope: For Unit –I, II, and IV : Chapter 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,24.

2. P. B. Bhattacharyya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2e), Cambridge Univ. Press, Indian Edition, 1997.

Scope: For Unit-III: Articles 5.4, 6.1, 6.2 and 6.3.

Reference Books:

1. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
2. M. Artin, Algebra, Prentice-Hall of India Pvt. Ltd.
3. I.N. Herstein, Topics in Algebra, Macmillan, Indian Edition.
4. J. B. Fraleigh, Abstract Algebra, 5th Edition.
5. I.S. Luthar, I. B. S. Passi, Algebra, Vol. 1, Groups, Narosa Publishing House.
6. N. Gopalakrishnan, University Algebra, New Age International.

MTU-102: Real Analysis

Unit-I: Real Number System, LUB axiom, Archemedian property. Equivalent Sets, countable and uncountable sets, Sequences of real numbers, convergent sequence, subsequence, monotonic sequence, Cauchy sequence, limsup, liminf. Metric spaces, Limits in Metric spaces. **(12L+3T)**

Unit-II: Open sets, closed sets, The Relative Metric**,** Continuous Functions, Homeomorphisms, The Space of Continuous Functions, Connected sets, Totally Bounded Sets, Complete Metric Spaces, Fixed Points, Completions. **(12L+3T)**

Unit-III: Compact Metric Spaces, Uniform Continuity, Continuous functions on Compact domains, Equivalent Metrics, Discontinuous Functions, Baire Category Theorem. **(12L+3T)**

Unit-IV: Sequence of functions, point wise and uniform convergence, Interchanging limits, The space of Bounded Functions, The Weierstrass theorem, equicontinuous family of functions, Arzela - Ascoli Theorem. **(12L+3T)**

Text Book: N.L. Carothers, Real Analysis, Cambridge University Press.

Scope: Chapters 1 to 11.

REFERENCES:

1. Ajit Kumar and S. Kumaresan, Basics of Real Analysis, CRC Press.
2. W. Rudin, Principles of Mathematical Analysis.
3. C. C. Pugh, Real Mathematical Analysis.
4. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House.
5. T. M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis, Springer Publications.

MTU 103 - Complex Analysis

Pre requisites: Sums and Products of complex numbers, Basic Algebraic Properties, Vectors and Moduli, Complex Conjugates, Exponential Form, Products and Powers in Exponential Form, Arguments of Products and Quotients, Roots of Complex Numbers.

Unit I: Functions of a Complex Variable, Mappings, Limits, Theorems on Limits, Limits Involving the Point at Infinity, Continuity, Derivatives, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Polar Coordinates, Analytic Functions, Harmonic Functions, Uniquely Determined Analytic Functions, Reflection Principle, The Exponential Function, The Logarithmic Function, Branches and Derivatives of Logarithms, Complex Exponents, Trigonometric Functions, Hyperbolic Functions, Inverse Trigonometric and Hyperbolic Functions. **(12L +3T)**

Unit II: Derivatives of Functions, Definite Integrals of Functions,Contour Integrals, Branch Cuts,Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Cauchy Integral Formula, Liouville's Theorem and the Fundamental Theorem of Algebra, Maximum Modulus Principle, Schwarz's lemma(from Ponnusammy's book) Convergence of Sequences and series, Taylor Series, Laurent Series, Absolute and Uniform Convergence of Power Series. **(12L +3T)**

Unit III: Isolated Singular Points, Residues,Cauchy's Residue Theorem,Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles,Zeros of Analytic Functions, Zeros and Poles, Behaviour of functions near isolated singular points, Evaluation of Improper Integrals, Jordan's Lemma, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouch´e's Theorem. **(12L +3T)**

Unit IV: Linear Transformations, The Transformation w = 1/z, Mappings by 1/z, Linear Fractional Transformations, An Implicit Form, Mappings of the Upper Half Plane, The Transformation w = sin z, Mappings by z2 and Branches of z1/2 . **(12L +3T)**

Textbook:

R.V.Churchill and J.W.Brown, Complex Variables and Applications (eighth edition), Mc Graw Hill Publication

Scope : Prerequisites- Chapter 1

Unit 1 – Chapter 2 and 3

Unit 2 - Chapter 4(excluding multiply connected domains) and Chapter 5(excluding continuity of sums of power series, integration and differentiation of power series, multiplication and division of power series)

Unit 3 - Chapter 6 and Chapter 7(excluding improper integral from Fourier Analysis, indented paths, integration along branch cuts, inverse Laplace transforms)

Unit 4 – Chapter 8 (excluding square roots of polynomials, Riemann surfaces)

References:

1) Foundation of Complex Analysis- S.Ponnusamy, Narosa Publication, Second Edition.
2) Functions of one Complex Variable - John B. Convey, Narosa Publishing House.
3) Complex Analysis - L. V. Ahlfors, Mc Graw Hill.
4) Functions of Complex Variables - H.Silverman
5) Complex Analysis - T.W.Gamelin, Springer Publications.

MTU-104: Ordinary Differential Equations

Unit I: Linear equations of first order, The second order homogeneous equation, initial value problems, Linear dependence and independence, A formula for the Wronskian, The homogeneous equation of order n, The non-homogeneous equation of order n, special method for solving non-homogeneous equation. **(12L +3T)**

Unit II: Linear equations with variable coefficients ,Initial value problem, solution of the homogeneous equation, Wronskian and linear independence, reduction of order of a homogeneous equation, Non-homogeneous equation, Homogeneous equations with analytic coefficients, The Legendre equation, The Euler equation, second order equation with regular singular points, The Bessel equation. **(12L +3T)**

Unit III: Equations with variables separated, exact equation, The method of successive approximations, The Lipschitz condition, convergence of successive approximations, Non-local existence of solutions, approximations to and uniqueness of the solutions. **(12L +3T)**

Unit IV: Some special equation, complex n-dimensional space, system as vector equations, existence and uniqueness of solution to systems, existence and uniqueness of solution for linear systems, equations of order n. **(12L +3T)**

Textbook:-

E. A. Coddington, An Introduction to Ordinary Differential Equation, Prentice-Hall of India Pvt. Ltd., New Delhi.

Scope: chapter 1 to 6

References :-

1] G. F. Simmons, Differential Equations with Applications and Historical Notes, (2nd edition) Mc Graw Hill Book Co.

2] G.Birkhoff and G.C.Rota, Ordinary Differential Equations, John Wiley and Sons.

MTU - 105: Advanced Discrete Mathematics

Unit I: Formal Logic: Statements, Symbolic Representation and Tautologies, Quantifiers, Predicates and validity, PrepositionalLogic. Semi groups and Monoids: Definitions and example of Semigroups and Monoids (including those pertaining to concatenation operations) Homomorphism of semigroups and monoids, Congruence relation and quotient semigroups, Subsemigroup and submonoids, Direct product, Basic Homomorphism Theorem. **(12L+3T)**

Unit II: Lattices: Lattices as partially ordered sets, their properties. Lattices as algebraic systems. Sublattices, Direct products and Homomorphisms, Some special lattices e. g. complete. Complemented and Distributive Lattices. **(12L+3T)**

Unit III: Boolean Algebras: Boolean Algebras as Lattices, Various Boolean Identities, The switching Algebra. Example, subalgebras, Direct Products and Homomorphisms, Joint-irreducible elements. Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of Products, Canonical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory(using AND, OR and NOT gates) The Karnaugh Map method. **(12L+3T)**

Unit IV: Coding Theory: Group codes, the communication model and basic notion, error correction, generation of codes by using parity checks, error recovering in group codes, Hamming distance. **(12L+3T)**

Reference Books:

1. J. P. Trembley and Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw-HillBookCo.1997.
2. Seymour Lipschutz, Finite Mathematics(International edition1983), McGraw-Hill Book
3. S.Wiitala, Discrete Mathematics-A Unified Approach, McGraw-Hill Book Co. New York.
4. J. L. Gersting, Mathematical Structures for Computer Science, (3rdedition).

MTU-106: Probability and Statistics

Unit I: Sets and classes, limit of a sequence of sets, fields, sigma-fields, monotone classes. Sample Space and Events, Axioms of Probability, Sample Spaces Having Equally Likely Outcomes, Conditional Probabilities, Bayes Formula, Independent Events. **(12L+3T)**

Unit II: Random Variables, Distribution Functions, Discrete Random Variables, Expected Value, Expectation of a Function of a Random Variable, Variance, Discrete distributions: uniform, binomial, geometric, negative binomial, hyper geometric, Poisson. Continuous distributions: uniform, exponential, gamma, Weibull, beta, normal, Cauchy. **(12L+3T)**

Unit III: Joint Distribution Functions, Independent Random Variables, Sums of Independent Random Variables, Conditional Distributions: Discrete Case and Continuous Case, Joint Probability Distribution of Functions of Random Variables. Expectation of Sums of Random Variables, Covariance, Variance of Sums, and Correlations, Conditional Expectation, Moment Generating Functions, Joint Moment Generating Functions. **(12L+3T)**

Unit IV: Problems on Chebyshev's and other inequalities, Modes of Convergence, Weak Law of Large Numbers, Strong Law of Large Numbers, Central Limit Theorem. **(12L+3T)**

Text Books:

[1] Sheldon Ross, A First Course in Probability, PRENTICE HALL India.

[2] VIJAY K. ROHATGI, A. K. MD. EHSANES SALEH, An Introduction to Probability and Statistics, second edition, Wiley series.

Reference Books:

1. Murray R. Speigel, Schaum's Outline of Probability and Statistics.
2. J.S. Milton & J.C. Arnold, Introduction to Probability and Statistics.
3. H.J. Larson , Introduction to Probability Theory and Statistical Inference.
4. S.M. Ross , Introduction to Probability and Statistics for Engineers and Scientists.
5. P. Halmos , Measure Theory (for algebra of sets)
6. Feller, W., Introduction to Probability Theory and its Applications, 3rd Ed., Wiley Eastern, 1978.
7. Prakash Rao, B.L.S., A First Course in Probability and Statistics, World Scientific, 2009.

MTU-107: LaTeX Typesetting

Unit I: Introduction to LaTeX, Installation of LaTeX, Layout Design, LaTeX input files, Input file structure, document classes, packages, environments, page styles, Typesetting texts, Fancy Header, tables.

Unit II: Inline math formulas and displayed equations, Math symbols and fonts, Delimeters, matrices, arrays, Typesetting Mathematical formulae: fractions, Integrals, sums, products, etc. Producing Mathematical Graphics.

MTU-108: Writing and Presentation using LaTeX

Unit I: Document classes for paper writing, thesis, books, etc. Table of contents, index, bibliography management, hypertext, pdfpages, geometry, fancy header and footer, Verbatim, itemize, enumerate, boxes, equation number.

Unit II: Beamer class, beamer theme, frames, slides, pause, overlay, transparent, handouts and presentation mode.

Semester-II

MTU -201: Linear Algebra

Pre-requisites: Basic theory of fields, Field extension, Examples, matrices, determinants, polynomials. Elementary Matrix Operations and elementary matrices, the rank of a matrix, System of linear equations-Theoretical Aspects, System of linear equations-Computational Aspects.

Unit I: Vector spaces: Introduction, Vector spaces, subspaces, Linear combinations and system of linear equations, linear dependence and independence, Bases and dimension, Maximal Linear Independent Subsets. **(12L+3T)**

Unit II: Linear Transformations and Matrices: Linear Transformations, Null spaces, and ranges, the matrix representation of a linear transformation, Composition of linear transformations, Invertibility and Isomorphisms, The change of Coordinate matrix, Dual spaces, and Homogeneous linear Differential equations with constant coefficients. **(12L+3T)**

Unit III: Diagonalization: Eigen values and eigen vectors, Diagonalizabity, Invariant Subspaces and the Cayley-Hamilton Theorem. **(12L+3T)**

Unit IV: Inner Product Spaces: Inner products and Norms, The Gram-Schmidt orthogonalization process and orthogonal complements, the adjoint of a linear operator, Normal and self-adjoint operators, Unitary and orthogonal operators and their matrices, orthogonal projections and the spectral theorem, Quadratic forms. Jordan Canonical form I, Jordan Canonical form II, The minimal polynomial, Rational Canonical form. **(12L+3T)**

Text Book: S.H.Friedberg, A.J.Insel, L.E.Spence: Linear Algebra, Prentice-Hall International, Inc., 3rd Edition.

Scope: Ch 1: Art.1.1 to 1.7, Ch 2:Art. 2.1 to 2.7, Ch 3:Art 3.1 to 3.4, Ch 5: Art 5.1,5.2,5.4, Ch 6:Art 6.1 to 6.7, Ch 7 : Art 7.1 to 7.4 .

Reference Books:

1. Vivek Sahai, Vikas Bist, Linear Algebra, Narosa Publishing House, 2nd Edition.
2. I. N. Herstein, Topics in Algebr, Macmillan, Indian Edition.
3. S.Lang, Introduction to Linear algebra,Springer International Edition,2nd Edition.
4. K.Hoffman,R.Kunze, Linear Algebra. Prentice Hall of India.
5. J.H.Kwak, S.Hong, Linear Algebra, Birkhäuser Verlag, 2nd Edition.
6. Harvey E.Rose, Linear Algebra.A pure Mathematical Approach, Birkhäuser Verlag.

MTU-202: Measure and Integration

Pre-requisites: Algebra of sets, The axiom of choice and infinite direct products, Open and closed sets of real numbers, continuous functions, Borel sets.

Unit I: Lebesgue measure: Introduction, outer measure, measurable sets and Lebesgue measure, a non measurable set, Measurable functions, Littlewood's three principles. **(12L+3T)**

Unit II: The Lebesgue integral: The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a nonnegative function, The general Lebesgue integral, convergence in measure. **(12L+3T)**

Unit III: Differentiation and integration: Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity, convex functions. **(12L+3T)**

Unit IV: Classical Banach spaces: The Lp spaces, The Minkowski and Holder inequalities, convergence and completeness. Approximation in Lp . Measure and Integration: Measure spaces, Measurable functions, Integration, General Convergence Theorems, Signed measures, The Radon-Nikodym Theorem. **(12L+3T)**

Text Book: - H. L. Royden: Real Analysis, 3rd Edition, PHI Learning Private Ltd.
Scope: - Chapter 1: Art.4 & 5, Chapter 2: Art.5,6 & 7,Chapter 3: Art.1 to 6,Chapter 4: Art.1 to 5,Chapter 5: Art.1 to 5,Chapter 6: Art.1 to 5, Chapter 11: Art.1 to 7.

Reference Books:

1. N.L. Carothers, “Real Analysis”, Cambridge university press.
2. P.R. Halmos: Measure theory, Narosa Publishing House.
3. Inder K.Rana : An Introduction to measure and Integration. Norosa publishing House, Delhi : 1997.
4. G. de. Barra; Measure theory and Integration,
5. P.K. Jain and V.P Gupta : Lebesgue measure and Integrtion , New age international (P) ltd publishing, New Delhi (Reprint 2000.)

MTU-203: Topology

Unit I: Topological Spaces, Basis for Topology, The Order Topology, The product Topology, The Subspace Topology , Closed Sets and Limit Points , Continuous functions, The Metric Topology. **(12L+3T)**

Unit II: Connected Spaces, Connected Subspace on Real Line. Compact Spaces, Compact Subspace on the Real Line, Limit Point Compactness, Local Compactness. **(12L+3T)**

Unit III: Countable Axioms: First countable, Second Countable, Separable, Lindelof, Separation Axioms: Regular and Normal spaces. **(12L+3T)**

Unit IV: The Urysohn's Lemma, The Urysohan Metrization Theorem and the Tychonoff Theorem. **(12L+3T)**

Text Book:

James R. Munkres: Topology, A first course, Prentice Hall of India. Pvt. Ltd. New Delhi-2000.

Scope:-

Chapter 2: Articles 12 to 21
Chapter 3: Articles 23, 24, 26, 27, 28, 29
Chapter 4: Articles 30 to 34.
Chapter 5: Article 37

Reference Books:

1. J. Dugundji Allya and Bacon, Topology, (1966) reprinted: Prentice Hall of India.
2. W. J. Pervin: Foundations of general topology, academic press Inc. N.Y. Hi] S. T.Hu: Elements of general topology. Holden day Inc. 1965.
3. Stephen Willard, General Topology, Addison-Wesley Publishing Company, 1970
4. Sheldon W. Davis, Topology (The Walter Rudin Student Series in Advanced Mathematics), TATA McGraw-Hill.2006.
5. Sidney A Morris, Topology without Tears, 2011 Version.

MTU-204: Partial Differential Equations

Unit I: First order PDE, classification of integrals, Linear equations of first order, Pfaffian differential equations, compatible systems, Charpit's method, Jacobi's method. **(12L+3T)**

Unit II: Classification of second order PDE, one dimensional wave equation, Laplace equation, Theory of Green's function for Laplace equation, Heat conduction problem, Duhamel's principle. **(12L+3T)**

Unit III: Fourier Series: Piecewise Continuous Functions, Fourier Cosine Series, Fourier Sine Series, Fourier series, adaptations to other intervals. **(12L+3T)**

Unit IV: Convergence of Fourier Series: One-Sided Derivatives, A Property of Fourier Coefficients, Two lemmas, A Fourier Theorem, Discussion of the theorem and its corollary, convergence on other intervals, A Lemma, Absolute and Uniform Convergence of Fourier Series, Differentiation of Fourier Series, Integration of Fourier Series. **(12L+3T)**

Text books:

1) T. Amarnath: An elementary course in PDE (2nd edition), Narosa Publishing House.

Scope:
Unit 1 :- Chapter 1(1.1 to 1.8)
Unit 2 :- Chapter 2(2.1 to 2.6)

2) R.V. Churchill and J. Brown.: Fourier Series and Boundary Value Problems, 7th edition, McGraw-Hill Book Company.

References:

1) W.E.Williams:"Partial Differential Equations",Claredon Press Oxford.

2) E.T.Copson:"Partial Differential Equations", Cambridge University Press

3) I.N.Sneddon:"Elements of Partial Differential Equation", Mc Graw Hill Co

MTU-205: Elementary Number Theory

Unit I: Divisibility Theory in the Integers: Division Algorithm, the Greatest common Divisor, The Euclidean Algorithm, The Diophantine Equations ax+by = c, Fundamental Theorem of Arithmetic. **(12L+3T)**

Unit II: Theory of Congruences: Basic Properties of Congruences, Binary and Decimal Representations of Integers, Linear congruence and the Chinese Remainder Theorem. Fermat Theorem: Fermat Little theorem and Pseudo primes, Wilson's Theorem, The Farmat –Kraitchik Factorization Method , The Equation x2+y2= z2 , Fermat's last Theorem. **(12L+3T)**

Unit III: Euler's Generalization of Fermat's Theorem: Sum and Number of divisors, The Mobius Inversion Formula, The greatest Integer function, Euler's Phi- Function, Euler's theorem, Properties of Phi function. **(12L+3T)**

Unit IV: Primitive Roots, Indices and the Quadratic Reciprocity Law: The Order of an Integer Modulo n , Primitive Roots for Primes , Composite Numbers having primitive Roots, Theory of Indices, Euler's Criterion , The Legendre Symbol and its Properties , Quadratic Congruences with Composite Moduli. **(12L+3T)**

Text Book: Elementary Number Theory, By David M. Burton .Tata McGRAW-HILL,2006,
Scope: Chapter 2 to Chapter 9,

Reference Books:

1. A Baker, A concise Introduction to the Theory of Numbers, Cambridge University Press 1984
2. J.P. Serre, A course in arithmetic-. GTM Vol.7, Springer Verlag 1973
3. Tom M. Apostol. ,Introduction to Analytic number theory Narosa Publishing house 1980
4. Niven and Zuckerman, An Introduction to the Theory of Numbers, 4th Ed Wiley, New York,1980,
5. Rosen K.H., Elementary Number Theory and its Applications Pearson Addision Wesely, 5th Edition.

MTU-206: Graph Theory

Unit I: Introduction to Graphs: graphs, subgraphs, paths, cycles, matrix representation of a graph, fusion. Trees and connectivity: definition and properties, bridges, spanning trees, cut vertices and connectivity. **(12L+3T)**

Unit II: Euler tour and Hamiltonian cycles, Euler tour, Euler Graph, the Chinese postman problem, Hamiltonian graphs, Travelling salesman Problem. **(12L+3T)**

Unit III: Planar Graphs: planar graphs, Euler's formula, Kuratowski's theorem, Non-Hamiltonian plane graphs, the dual of a plane graph. **(12L+3T)**

Unit IV: Directed graphs and Networks: definitions and properties,Tournaments,Traffic flow, The Ford and Fulkerson Algorithm, Seperating sets. **(12L+3T)**

Textbook:

A First Look at Graph Theory: John Clark and Derek Allan Holton Allied Publishers Ltd.
Chapters:-1, 2, 3,5,7,8

Reference Books:

1. Graph Theory With Applications to Engineering and Computer Science: Narsing Deo, Prentice Hall of India.
2. Graph Theory: F. Harare, Addison Wesley.
3. Introduction to Graph Theory: Douglas B. West, Prentice- Hall, New Delhi (1999)
4. Basic Graph Theory: K. R. Parthasarthy, Tata Mc Graw- Hill Pub Comp Limited Delhi.

MTU-207: Programming in SciLab

Unit I: Introduction to SciLab, Installation of SciLab, Basic elements of the language, Looping and Branching: If, select, for, break, continue, Functions, return, Contour plots, tiles, axes, legends.

Unit II: Matrices: Creating matrices, sum, product of matrices, inverse, rank determinant, comparing matrices, system of equations, High level linear algebra features, working with polynomials, plotting 2D and 3D graphs, defining a function and output arguments.

MTU-208: Mathematical tools in SciLab

Unit I: SciLab Demonstrations: Polynomials, discrete and continuous Random variables, Tcl/tk, spreadsheet, GUI: unicontrols, unicontrols with latex.

Unit II: Basic functions, animation, finite elements, Bezier curves and surfaces, matplot, complex elementary functions. Scilab help browser for mathematics. Parametric plots, Polar plots, Matrix Operations, Matrix inversions, Solving system of equations. Evaluation of definite integrals, Generating prime numbers, Illustration of Rolle's and Mean value theorems.

Semester-III

MTU-301: Galois Theory

Unit-I: Rings, examples of rings, ideals, prime and maximal ideals. Integral domains, Euclidean Domains, Principal Ideal Domains and Unique Factorizations Domains. Polynomial rings over UFD's. **(12L+3T)**

Unit-II: Fields, Characteristic and prime subfields, Field extensions, Finite, algebraic and finitely generated field extensions, algebraic closures. **(12L+3T)**

Unit-III: Splitting fields, normal extensions, Multiple roots, Finite fields, Separable Extensions. **(12L+3T)**

Unit-IV: Galois groups, Fundamental Theorem of Galois Theory, Solvability by radicals, Galois' Theorem on solvability. Cyclic and abelian extensions. Classical ruler and compass constructions. **(12L+3T)**

Text Book: P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra, 2nd Ed., Cambridge University Press.

Scope: Chap 9: Art 9.1, 9.3
Chap 10: Art 10.1, 10.4.
Chap 11, 15 to 18.

Reference Books:

1. D.S. Dummit and R. M. Foote, Abstract Algebra,2nd Ed., John Wiley, 2002.
2. Joseph Rotman, Galois Theory, 2nd Ed., Sringer International Edition
3. N. Jacobson, Basic Algebra I, 2nd Ed., Hindustan Publishing Co., 1984,
4. S. Lang, Algebra I, III Edition, Addison Wesley, 2005

MTU-302: Functional Analysis

Unit-I: Definition and some Examples of Banach Spaces, continuous linear transformations, The Hahn-Banach Theorem, The Natural embedding of N in N**. **(12L+3T)**

Unit-II: The open Mapping Theorem, The conjugate of an operator. The definition and some simple properties of Hilbert Spaces, orthogonal complements, orthonormal sets. **(12L+3T)**

Unit-III: The conjugate space H*, The adjoint of an operator, self adjoint operators, Normal and Unitary Operators, projections. **(12L+3T)**

Unit-IV: Finite Dimensional Spectral Theory: Introduction, Matrices, Determinants and spectrum of an operator, The spectral Theorem. **(12L+3T)**

Text Book: G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, International student Edition, New York.

Scope: Articles 46 to 62

Reference Books:

1. B.V. Limaye, Functional Analysis, Wiley Eastern Ltd.
2. G. Bachman and L. Narici, Functional Analysis.
3. Kreyszig , Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978Academic Press 1966.
4. J. B. Conway, A course in functional analysis, Springer-Verlag, New York 1990.
5. S.Ponnusamy, Foundations Of Functional Analysis, Narosa Publishing House

MTU-303: Fractional Calculus and its Applications

Unit I: Gamma and Beta Functions: Definition of the Gamma and Beta Functions, Some properties of Gamma and Beta Functions, Relation between Gamma and Beta Functions. Special Function: Definition of Mittag-Leffler Functions of one and two parameters, Relations of Mittag-Leffler Function to some other functions, The Laplace transform of Mittag-Leffler Function in two parameters. Wright Function, Definition of Wright function, Integral relation and relation to other functions. **(12L+3T)**

Unit II: Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivatives, Caputo's fractional derivative, Fractional derivatives of standard functions and their graphical representation by Mathematical softwares, Fractional integrals, Geometric and physical interpretation of fractional integral and fractional differentiations. Left and right fractional derivatives. **(12L+3T)**

Unit III: Laplace transform of fractional derivatives, Fourier transform of fractional derivatives and Mellin transform of fractional derivatives. **(12L+3T)**

Unit IV: Applications: Linear fractional differential equations (homogeneous fractional differential equations and non-homogeneous fractional differential equations), Existence and uniqueness theorem as a method of solution, Laplace transform method to solve fractional differential equations, Fourier transform method to solve fractional differential equations. **(12L+3T)**

Text Book:

Igor Podlubny - Fractional Differential Equations, Academic press, San Diego, California.

Reference books:

1. Miller K. S. and Ross B. – An Introduction to Fractional Calculus and Fractional Differential Equations, New York, John Wiley, 1993.
2. Oldham K. B. and Spanier J. – The Fractional Calculus, New York, Academic press, 1974.
3. Igor Podlubny - Fractional Differetial Equations, Academic Press, Boston, New York.
4. Anatoly A. Kilbas, Hari M. Shrivastav, Juan J. Trujillo- Theory and Applications of Fractional Differential Equations, Elesevier, New York 2006.
5. Shananu Das – Functional Fractional Calculus, 2011 Springer-Verlag, Berlin Heidelberg.

MTU-304: Operations Research

Unit I: Operations research and its scope, Necessity of operations research in industry, Linear programming problems, Convex sets, Simplex method, Theory of simplex method, artificial variable technique, Duality theory, Dual simplex method. Revised simplex method and Sensitivity analysis. **(12L+3T)**

Unit II: Transportation and Assignment problems, travelling salesman problem. **(12L+3T)**

Unit III: Game Theory: Introduction, competitive game, finite and infinite game, two person zero sum game, rectangular game, solution of game. PERT-CPM, product planning control with PERT-CPM. **(12L+3T)**

Unit IV: Inventory Control: Costs Associated with Inventories-Factors affecting Inventory Control-Economic Order Quantity (EOQ), Deterministic Inventory Problems with no Shortages and with Shortages, Characteristics and Corollary. Queuing theory: Steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space. **(12L+3T)**

Text Books:

1. Dr. R. K. Gupta: Linear Programming, Krishna Prakashan Mandir.
2. F.S.Hillier and G.J.Liebermann, Introduction to Operations Research (6th Ed.), Mc Graw Hill International Edition, Industrial Engineering Series, 1995.
3. Kantiswaroop, P.K.Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi.

Reference Books:

1. G.Hadley, Linear Programming, Narosa publishing House, 1995.
2. G.Hadley, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
3. H.A.Taha, Operations Research: An Introduction, Macmillan Publishing Company, New York.
4. S.S.Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
5. Prem Kumar Gupta and D. S. Hira, Operations Research - An Introduction. S.Chand & company Ltd, New Delhi.
6. N.S.Kambo, Mathematical Programming Techniques. Affiliated East-West Press Pvt.Ltd, New Delhi, Madras.

MTU-305: Analytic Number Theory

Unit I: Elementary theorems, Prime numbers, Distribution of prime numbers, The function $\pi(x)$, its properties, The Prime Number Theorem. **(12L+3T)**

Unit II: Riemann Zeta Function:-zeta function, Riemann zeta function, Riemann Hypothesis, connection between $\xi(s)$ and primes, Dirichlet L-functions, Dedekind zeta function, prime number theorem and RH ,Extended Riemann Hypothesis(ERH),Generalized Riemann Hypothesis(GRH),zeros of the Riemann zeta function on the critical line. **(12L+3T)**

Unit III: Study on RH:-Equivalent forms of RH and ERH, study on claims to prove RH, product formula for ξ,proof of Riemann's main formula, derivative of the Riemann zeta function, the theorem of Hadamard and De le Vallee Poussin and its consequences, Lindelof Hypothesis, RH and Finite field theory. **(12L+3T)**

Unit IV: Applications:-Applications of RH and ERH in different fields, consequences of RH, RH for the Hilbert Spaces of entire functions. **(12L+3T)**

Text Book:

Riemann zeta function, H.M.Edward, Academic Press.

Reference Books:

1) The distribution of prime numbers, G.H.Hardy, E.Cunningham, (Cambridge University Press)
2) Theory of Riemann zeta function, E.C.Titchmarsh,(Oxford Press)
3) Little book of bigger primes, Paulo Ribenboim,(Springer International Edition)

MTU-306: Lattice Theory

Unit I: Two definitions of lattices, Hasse diagrams, homomorphism, isotone maps, ideals, congruence relations, congruence lattices, the homorphism theorem, product of lattices, complete lattice, ideal lattice, distributive –modular inequalities and identifies, complements, pseudocomplements, Boolean lattice of pseudo complements, join and meet-irreducible elements. **(12L+3T)**

Unit II: Characterization theorems and representation theorems-Dedekind`s modularity criterion Birkhoff`s distributivity criterion, hereditary subsets, rings of sets, Stone theorems, Nachbin theorem, statements of Hashimoto's theorem. **(12L+3T)**

Unit III: Modular lattices, isomorphism theorem, Upper and lower covering conditions, Kuros-Ore theorem, independent sets. **(12L+3T)**

Unit IV: Semi modular lattices Jordan-Holder chain condition, Modular pair, M-sysmmetric lattices. **(12L+3T)**

Text Book:

G. Gratzer- Birkhauser, General Lattice Theory, IInd Edition 199.
Chapter- 1 (Section 1,2, 3,4,6)
Chapter – 2(Section -1)
Chapter-3(Section –1, 2)

Reference book :

Vijay K. Garg, Introduction to lattice theory with computer science applications, John Wiley and Sons.

MTU- 307: CODING THEORY

Unit I: Communication channels, Maximum likelihood decoding, Hamming distance, Nearest neighbor / minimum distance decoding, Distance of a code. **(12L+3T)**

Unit II: Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes, Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome decoding. **(12L+3T)**

Unit III: Definitions, Generator polynomials, Generator and parity check matrices, Decoding of cyclic codes, Burst-error-correcting codes. **(12L+3T)**

Unit IV: BCH codes, Definitions, Parameters of BCH codes, Decoding of BCH codes. **(12L+3T)**

Textbook:

San Ling and Chaoping Xing, Coding Theory- A First Course, Cambridge University Press, 1st Edition.

Scope: Chapters 2, 4, 6 and 8.

Reference Books:

1. Lid and Pilz , Applied Abstract Algebra - 2nd Edition.

2. R. Lidl, H.Neiderreiter , Introduction to finite fields and their applications, Cambridge University Press.

MTU- 308: Riemannian Geometry

Unit I: Riemannian metric , metric tensor, Christoffel Symbol , Christoffel Symbol of first kind, second kind, Properties of Christoffel Symbol, Computations of Christoffel's Symbol for static and non static spherically symmetric and R-W space time, transformation of Christoffel Symbol, derivatives of tensor, absolute derivative, covariant derivatives , divergence, gradient, Laplacian. **(12 L+ 3T)**

UNIT II: Parallel vector Fields: Parallel vector field of constant magnitude, parallel displacement of covariant vector field, Parallelism of vector field of variable magnitude. Geodesic: Differential equations of Geodesic. Special Co-ordinate systems: Local Cartesians, Riemannian Co-ordinates, Normal Co-Ordinates, Geodesic normal co-ordinate. **(12 L+ 3T)**

UNIT III: Curvature tensor: Covariant curvature tensor of Riemann tensor, Curvature tensor in Riemannian co-ordinates, properties of curvature tensors, on a cyclic property, number of independent components of R. **(12 L+ 3T)**

UNIT IV: Ricci tensor, curvature invariant, Einstein tensor, Computation of Einstein's tensor for static and non static spherically symmetric and R-W space time, the Bianchi identity, Geodesic deviation: Equations of Geodesic deviation. Riemannian curvature, space of constant curvature, flat space, Cartesian tensor. **(12 L+ 3T)**

Reference Books:

(1) T. M. Karade, G. S. Khadekar, and Maaya S. Bendre, Lecture on General Relativity , Sonu Nilu Publication
(2) T. J. Willmore, An Introduction in Differential Geometry .
(3) J. L. Synge, Tensor Calculus, Schild
(4) C. E. Weatherburn , An Introduction to Reimannian Geometry and Tensor Calculus, Cambridge University Press -1963
(5) L. P. Eisenhard , Reimannian Geometry, University Press Princeton 1926
(6) J . A. Schouten, Ricci Calculus, Springer Verlag Berlin
(7) T. Y. Thomas, Concept from Tensor Analysis and Differential Geometry, Academic Press, New York.
(8) W. Boothby, Introduction to Differentiable Manifold and Reimannian Geometry , Academic Press , 1975
(9) S. Kobayashi and K. Nomizu, Foundations of Differential Geometry, Vol. I and Vol. II, Wiley Interscience Publisher, 1961(Vol.I) , 1969 (Vol.II)

MTU-309: Algebraic Topology

Unit I: Category and Functors, Homotopy, Properties of Homotopic Mappings, Relative Homotopy, Homotopy Type, Contractible Spaces, Retractions, paths, Path Connected Spaces, Equivalent Paths. **(12L+3T)**

Unit II: Fundamental Group: Product Path, Formation of a Group, Isomorphism of Fundamental Groups, Homomorphism of Fundamental Groups, Induced Homomorphism, The Homotopy Groups. The fundamental group of a circle, torus, etc. Applications of Fundamental group. **(12L+3T)**

Unit III: Covering Spaces: Definitions, Local Homeomorphism, G-Spaces, Properties of Covering Maps, Fundamental Group of the Covering Space, Fibrations: Unique Path Lifting, Fibrations and EquivalentPaths, Covering Map and Fibrations. **(12L+3T)**

Unit IV: Geometrie Simplexes and Complexes : Geometrically Independent Set, Simplexes, Orientation of Simplexes, Complexes, Triangulation, Simplicial Mapping, Topological Dimension, The Brouwer Fixed Point Theorem, Barycentric Subdivision. Simplicial Homology Theory : Finitely Generated Abelian Group, Chains, Incidence, Boundaries, Cycles, Homology Groups, Connected Complex. **(12L+3T)**

Text Book:

B.K. Lahiri, A First Course in Algebraic Topology, Alpha Science International Ltd.

Scope: Chapters 1 to 11.

Reference Books:

1. Czes Kosniowski, A First Course in Algebraic Topology, Cambridge University Press.
2. William S. Massey, A First Course in Algebraic Topology, Sringer Verlag.
3. Fred H. Croom, Basic Concepts of Algebraic Topology, Sringer Verlag.
4. Allen Hatcher, Algebraic Topology, Cambridge University Press.
5. W. Fulton, Algebraic topology: A First Course, Springer-Verlag, 1995.
6. J.R. Munkres, Elements of Algebraic Topology, Addison Wesley, 1984.
7. J. R. Munkres – Topology – A First Course (Prentice-Hall of India, 1978).
8. Singer, I.M., *Thorpe*, J.A, Lecture Notes on Elementary Topology and Geometry, Sringer Verlag

MTU-310: Representation Theory of Finite Groups

Unit I: Representations, Subrepresentations, Tensor products, Symmetric and Alternating Squares. **(12L+3T)**

Unit II: Characters, Schur's lemma, Orthogonality relations, Decomposition of regular representation, Number of irreducible representations, canonical decomposition and explicit decompositions. Subgroups, Product groups, Abelian groups. Induced representations. **(12L+3T)**

Unit III: Examples, Cyclic groups, alternating and symmetric groups. **(12L+3T)**

Unit IV: Integrality properties of characters, Burnside's pa qb theorem, The character of induced representation, Frobenius Reciprocity Theorem, Mackey's irreducibility criterion, Examples of induced representations, Representations of supersolvable groups. **(12L+3T)**

Text book:

B. Steinberg, Representation Theory of finite groups, Springer, 2012.
Chapter 1-8

Reference books:

1) W. Fulton, J. Harris, Representation Theory: A first course, Graduate Texts in Mathematics.
   Readings in Mathematics 129. Springer Verlag (1991). International Edition (Low priced Ed.)
2) M. Burrow, Representation Theory of Finite Groups, Academic Press, 1965.
3) N. Jacobson, Basic Algebra II, Hindustan Publishing Corporation, 1983.
4) S. Lang, Algebra, 3rded. Springer (India) 2004.
5) J.P. Serre, Linear Representation of Groups, Springer-Verlag, 1977
6) C. Musili, Representations Finite Groups, Hindustan Book Agency, 1993.
7) E. B. Vinberg: Linear Representations of Groups, Birkhäuser (1988)
8) J.L.Alperin and R.B.Bell, Groups and Representations, Springer, 1995.

MTU-311: Difference Equations

Unit I: Introduction, Difference Calculus: The difference operator, generating function and approximate summation. Linear Difference equations: First order equations, general results for linear for linear equations, equations with constant coefficients. **(12L+3T)**

Unit II: Solving linear equations, applications with variable coefficients, non linear equations that can be linearized. The Z-transform: Properties, initial and final value theorem, partial sum theorem, convolution theorem, Inverse Z-transforms, solution of difference equation with constant coefficients by Z-transforms. **(12L+3T)**

Unit III: Stability Theory: Initial Value Problems for linear systems. Stability of linear systems, stability of non- linear system, Chaotic behavior. **(12L+3T)**

Unit IV: Asymptotic Methods: Introduction, asymptotic analysis of sums, linear equations, non- linear equations. **(12L+3T)**

Text Book:

1) Difference equations: An introduction with applications by Walter G. Kelley and Allan C. Peterson, Elsevier, 2nd edition, 2012(Indian reprint). Chapter 1 to 5, except 2.2, 4.3, 4.5.

Reference Books:

2) Discrete Hamiltonian systems, Difference equations, continued Fractions and Riccati Equations by Calvin Ahlbrandt and Allan C-peterson; Kluwer, Bostan, 1996.
3) An introduction to difference equations by Saber Elaydi, Springer.
4) Difference Equations by Pundir S. K. and Pundir R., Pragati Prakashan Meerut.

MTU-312: Programming in C

Theory

1. Introduction to Programming languages, C-language and its features
2. Understanding structure of program in C
3. Basic data types, Libraries in C
4. Operators and Expressions in C
5. Functions used for input and output in C
6. Conditional Branching in C, use of If-Then
7. Looping in C, use of for loop, while loop, do-while loop, nested loops
8. Algorithm and flowchart

Practicals

1. Some simple programmes using C
2. Leap year
3. Generate first n-primes
4. Roots of quadratic equation
5. Convert a number to any given base
6. Generate first n perfect numbers
7. Sine and cosine series by Taylor series
8. Addition and multiplication of matrices
9. Inverse of a matrix
10. Transpose of a matrix

MTU- 313: Methods in Numerical Analysis using C

Practicals

1. Finding roots of a polynomial using Bisection Method
2. Newton-Raphson Method
3. Regula-Falsi Method
4. Gauss Elimination Method
5. Gauss-Seidal Method
6. Simpson's $1/3^{rd}$ rule and $3/8^{th}$ rule
7. Trapezoidal Rule
8. Solution of differential equation using Euler's Method
9. Runge-Kutta Method
10. Lagrange's Interpolation

Semester-IV

MTU-401: Commutative Algebra

Unit I: Rings and ring homomorphisms, ideals, quotient rings, zero divisors, nilpotent elements, units, prime ideals and maximal ideals, nil radical and Jacobson radical, operations on ideals, extension and contraction. **(12L+3T)**

Unit II: Modules and module homomorphisms, sub modules and quotient modules, operations on sub modules, Direct sum and product, finitely generated modules, exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, Algebras, Tensor product of algebras. **(12L+3T)**

Unit III: Local properties, Extended and contracted ideals in ring of fractions, Primary Decomposition. Integral dependence, the going-up theorem, integrally closed integral domains, the going- down theorem, chain conditions. **(12L+3T)**

Unit IV: Primary decomposition in Noetherian rings, Artin rings, Discrete valuation rings, Dedekind domains, fractional ideals. **(12L+3T)**

Text Book:

M. F. Atiyah and I. G. Macdonald, Introduction to Commutative Algebra, Addison-Wesley Publishing Company.

Scope: Chapter 1 to Chapter 9.

Reference Books:

1. H.Matsumura, Commutative Ring Theory, Cambridge University Press.
2. N. S. Gopalakrishnan, Commutative Algebra.
3. D.S. Dummite and R.M. Foote, Abstract Algebra, Second ed., John Wiley & Sons.
4. D.P. Patil, Patil, Storch, Introduction to Algebraic Geometry and Commutative Algebra, Anshan Publishers.
5. S. Lang, ”Algebra”, Springer(GTM).

MTU-402: Integral Equations and Transforms

Unit I: Types of integral equation, Types of Kernels, Eigen values and eigen functions, convolution integral , relation between differential equation and integral equation, relation between integral equation and boundary value problems, green's function. **(12L+3T)**

Unit II: Solution of Homogeneous Fradholm integral equation of the second kind with separable kernel, Fredholm theorem, iterated kernel, method of successive approximations, an approximate method, complex Hilbert spaces, orthonormal system of functions, Riesz-Fischer theorem, Hilbert –Schmidt theorem and its application for the solution of Fredholm integral equation with symmetric kernel. **(12L+3T)**

Unit III: Iterated kernels, Neumann series for Volterra integral equation, singular integral equation solution of Abel's integral equation, weakly singular kernel, Cauchy principal for integrals, Cauchy type integrals, solution of Cauchy type singular integral equation. **(12L+3T)**

Unit IV: Fourier Transforms:-Definition, properties evaluation of Fourier and inverse Fourier transforms of functions, Convolution theorem for Fourier Transform, Sine and Cosine Fourier transforms, solving integral equations using Fourier Transform. Laplace Transform:-Definition , properties, evaluation of Laplace and Inverse Laplace transforms of functions, Convolution theorem for Laplace Transforms, solving initial value problem using Laplace Transforms, solving integral equation using Laplace Transforms. **(12L+3T)**

Textbooks:

1. Linear Integral Equations(Theory and Technique) – Ram P.Kanwal, Birkhauser

2. Advanced Differential Equations(12th Revised Ed) –M. D. Raisinghania ,S. Chand pub.

Scope :

Unit 1- Kanwal's book (Chapter 1 and Chapter 5(5.1 to 5.3, 5.5 to 5.7))

Unit 2- Kanwal's book (Chapter 2 , Chapter 3(3.1, 3.2) and Chapter 7(7.1, 7.4, 7.5, 7.6))

Unit 3- Kanwal's book (Chapter 3(3.3, 3.4) and Chapter 8(8.1 to 8.5))

Unit 4- From Raisinghania's Book

Reference Books:

1] A First course in integral equations - A.M. Wazwaz (world Scientific)

2] Introduction to Integral Equation with Applications (2nd edition) - A.J. Jerri (Wiley Interscience)

MTU-403: Lie Groups and Lie Algebra

Unit I: Definition of a matrix Lie group, Examples of matrix Lie groups, Compactness, connectedness, simple connectedness, The polar decomposition for SL(n, R) and SL(n,C), Lie groups. **(12L+3T)**

Unit II: The matrix exponential, The matrix Logarithm, The Lie algebra of matrix Lie group,Properties of Lie Algebra, The complexification of Real Lie algebra. **(12L+3T)**

Unit III: The Baker-Campbell-Housdorff formula for the Heisenberg group, The general Baker-Campbell-Housdorff formula, The derivative of the exponential mapping, Group versus Lie algebra homomorphism, covering groups, subgroup and subalgebras. **(12L+3T)**

Unit IV: The representations of SU(3), weights and roots, The theorem of the highest weight, The Weyl group, Weight diagrams, Complete reducibility and semisimple Lie Algebras, Cartan subalgebras, Roots and root spaces, Inner products of roots and co-roots, Positive root. **(12L+3T)**

Text book:

B. C. Hall, Lie groups, Lie Algebras and representations: An elementary introduction, Springer (Indian reprint, 2004).

Reference Books:

1) J. E. Humphreys, Introduction to Lie Algebras and representation theory, Springer Verlag(1992)
2) S. C. Bagchi, S. Madan, A. Sitaram and U. B.T iwari, A first course on representation theory and linear Lie groups, University Press (2000).

MTU-404: Algorithms and Their Analysis

Unit I: Algorithms; Assignment, arithmetic, relational, logical operators; Truth tables; input/output statements; conditional statements; iterative statements. **(12L+3T)**

Unit II: functions; recursion, recursion trees, binary trees ; worst-case, best-case, average-time requirements; recurrence relations; P,NP,NP-completeness, NP-Hard problems; lower bound of time requirements. **(12L+3T)**

Unit III: Algorithms to be discussed: Min, max, average, standard deviation, Linear and binary search (iterative and recursive), Simple sorts: selection and bubble, Factorial (iterative and recursive), Fibonacci (iterative and recursive). **(12L+3T)**

Unit IV: Algorithms to be discussed: Tower of Hanoi (iterative and recursive), Merging sorted lists, NlogN sorts: Merge sort and heap sort, Matrix multiplication: Iterative O (n^3) versus Strassen's recursive algorithm O (n^2.807), A brief look at Coppersmith–Winograd algorithm O(n^2.376), Prime numbers. **(12L+3T)**

Text Books:

(1) S. Lipschutz, ”Data Structures”, Schaum’s Outline series.

(2) Dino Mandrioli, Carlo Ghezzi “Theoretical Foundations of Computing Science”, Wiley, 1987

MTU-405: Algebraic Geometry

Unit I: Introduction; affine varieties, Hilbert's Nullstellensatz, polynomial function and maps; rational functions and maps. **(12L+3T)**

Unit II: Projective space; projective varieties; rational functions and morphisms; smooth points and dimension, smooth and singular points, algebraic characterizations of the dimension of a variety. **(12L+3T)**

Unit III: Plane cubic curves, plane curves, intersection multiplicity, classification of smooth cubics, the group structure of an elliptic curve. **(12L+3T)**

Unit IV: Cubic surfaces, the existence of lines on a cubic, configuration of the 27 lines, rationality of cubics. **(12L+3T)**

Text Book:

Elementary Algebraic Geometry – K. Hulek (translated by H. Verrill), Student Mathematical Library, vol 20, American Mathematical Society, 2003.

Reference Books:

1. J.S. Milne, Algebriac Geometry, version 6.01.
2. Karen E. Smith, et.al, An Invitation to Algebraic Geometry, Springer.
3. J. Harris, Algebraic Geometry: A First Course, Springer-Verlag, 1992.
4. M. Reid, Undergraduate Algebraic Geometry, Cambridge University Press, Cambridge, 1990.
5. I.R. Shafarevich, Basic Algebraic Geometry, Springer-Verlag, Berlin, 1974.
6. Algebraic Geometry – R. Hartshorne, Springer-Verlag, 1977.

MTU-406: Classical Mechanics

Unit I: Mechanical of system of particles, Mechanics of system of particles, Conservation theorems conservative forces with examples, Constraints, Generalized co-ordinates. D. Alembert's principle, Lagrange's equations of motion. The forms of Lagrange's equations of motion for non conservative systems and partially conservative and partially non conservative systems. Kinetic energy as a homogeneous function of generalized velocities. Simple applications of the Lagranian formulation. **(12L+3T)**

Unit II: Cyclic co-ordinates and generalized momentum conservation Theorems, Calculus of variation, Euler Lagrange's equation, First integrals of Euler Lagrange's equation, the case of several dependent variables, Geodesics in a plane, the minimum surface of revolution, Brachistochrome problem. Isoperimetric problems, problems of maximum enclosed area. **(12L+3T)**

Unit III: Hamilton's Principle for conservative systems, Lagrange's equation from Hamilton principle for conservative system, Hamiltonian function. Hamiltonian canonical equations of motion, Derivation of Hamiltonian equation from variational principle, Physical significance of Hamiltonian, The principle of least action, Jocobi's form of the least action principle, Cyclic co-ordinates and Routh's procedure. **(12L+3T)**

Unit IV: The independent co-ordinates of a rigid body, Orthogonal transformations, Properties of transformation matrix, Infinitesimal rotations, The Eulerian angles, The Calyley-Klein parameters, Eulers theorem on motion of rigid body, Angular momentum and kinetic energy of motion of a rigid body about a point. **(12L+3T)**

Text Book:

Goldstein H, Classical Mechanics, Narosa Publishing House, (Second edition)

Reference Books:

1) Goldstein Pooler & Saflco, Classical Mechanics, Pearson Educations.
2) N.C. Rana & P. S. Jog, Classsical Mechanics, Tata Mc.Graw Hill (1992).

MTU-407: Theory of Relativity

Unit I: Review of the special theory of relativity and the Newtonian theory of gravitation. Galilean and Laurentz transformations. Distinction between Newtonian space and relativistic space. The conflict between Newtonian theory of Gravitation and Special Relativity. The action principle, the energy momentum tensor. **(12L+3T)**

Unit II: The stress energy momentum tensor for Incoherent matter, perfect fluid, electromagnetic field. Einstein's Relativity: SR to GR, Non-Euclidean space-time, General relativity and gravitation, desirable features of gravitational theory. Principle of equivalence, Principle of covariance and Mach's Principles. **(12L+3T)**

Unit III: Einstein's field equations, Derivation of Einstein's field equations from action principle, Flat space and empty space. Local conservation laws associated with perfect fluid distribution. Newtonian approximation: Relation between g44 and V, Einstein equations compared with Poisson equation. **(12L+3T)**

Unit IV: Spherical symmetry, Einstein's field equations under spherical symmetry, Schwarzschild exterior solution and its isotropic form, Planetary orbits, General relativistic Kepler problem, Three crucial tests for general Theory of relativity: 1. Perihelion of the planet Mercury, 2. Bending of light, 3. Gravitational red shift, Schwarzschild interior solutions. **(12L+3T)**

References:

(1) Introduction to General Relativity – Ronald Ader, Maurice Bazin, Menahem Schiffer, 2 Edition, McGraw Hill Company.
(2) Lectures of Relativity – T. M. Karade, et. al, Einstein Foundation International Nagpur.
(3) General Relativity and Cosmology – J. V. Narlikar, Macmillan Company of India, 1978.
(4) Gravitation and Cosmology: Principles and Applications of General theory of Relativity – Steven Weinberg, John Wiley Pblication.
(5) Relativity, Thermodynamics and Cosmology – R. C. Tolman (Oxford Press).
(6) Mathgematical Teory of Relativity – A. S. Eddington, Cambridge University Press, 1965.
(7) Dr. S. R .Roy, Dr. Raj Bali, Theory of Relativity, Jaipur publishing house.
(8) H. Stepheni: General Relativity: An Introduction to the theory of gravitational field, Cambridge University press, 1982.
(9) R. Resnicik, Introduction to special relativity, Wiley Eastern Ltd.

MTU-408: Cryptography

Unit I: Time estimates for doing arithmetic, divisibility and Euclidean algorithm, congruences, quadratic residues and reciprocity, Fermat's little theorem, applications to factoring, finite fields. **(12L+3T)**

Unit II: Classical cryptosystems, Public key cryptography, Hash function, Probabilistic encryption, RSA cryptosystem, Pseudo primes, Pollard's P-1 method, The Rho method. **(12L+3T)**

Unit III: The ElGamal cryptosystem, discrete logarithm, Diffee-Hellman key exchange system, Algorithms for discrete logarithm problem- Shank's algorithm, the Pollard Rho algorithm, the Pohlig-Hellman Algorithm, security of ElGamal systems, the ElGamal signature scheme. **(12L+3T)**

Unit IV: Elliptic curves, Elliptic curve cryptosystems, Elliptic curve primality test, Elliptic curve factorization. **(12L+3T)**

Text books:

1) Neal Koblitz, A Course in Number Theory and Cryptography (second edition), Springer-Verleg.
2) Douglas R. Stinson, Cryptography: Theory and practice (Third Edition), CRC Press.

Scope :

Unit 1- From Koblitz's book (Chapter 1 and Chapter 2 excluding Existence and uniqueness of finite fields with prime power number of elements)

Unit 2 – From Koblitz's book (Chapter 4 –sections 1 and 2, Chapter 5- sections 1 and 2)

Unit 3 – From Stinson's book (Chapter 6- section 1and 2, Chapter 7- section 3)

Unit 4 - From Koblitz's book (Chapter 6)

Reference Books:

William Stallings, Cryptography and Network Security, Prentice Hall.

MTU-409: Algebraic Number Theory

Unit I: Algebraic number fields. Localisation, discrete valuation rings. **(12L+3T)**

Unit II: Integral ring extensions, Dedekind domains, unique factorisation of ideals. Action of the Galois group on prime ideals. **(12L+3T)**

Unit III: Valuations and completions of number fields, discussion of Ostrowski's theorem, Hensel's lemma, unramified, totally ramified and tamely ramified extensions of p-adic fields. **(12L+3T)**

Unit IV: Discriminants and Ramification. Cyclotomic fields, Gauss sums, quadratic reciprocity revisited, The ideal class group, finiteness of the ideal class group, Dirichlet units theorem. **(12L+3T)**

Text book:

D. A. Marcus, Number Fields, SpringerVerlag, 1977

Reference Books:

1) K. Ireland and M. Rosen, A Classical Introduction to Modern Number Theory, 2nd Edition, Springer-Verlag, Berlin, 1990.
2) S. Lang, Algebraic Number Theory, AddisonWesley, 1970.
3) D. A. Marcus, Number Fields, SpringerVerlag, 1977.
4) G. J. Janusz, Algebraic Number fields,(chapter 1-4), AMS(1996).
5) I. Stuart and D.Tall, Algebraic Number Theory and Fermat's last theorem,A.K.Peters(2001)
6) E. Weiss, Algebraic number theory, Dover Publications, 1998.

MTU-410: Fuzzy Sets and Applications

Unit I: Fuzzy sets: basic definition, α level sets, convex fuzzy sets, basic operations on fuzzy sets, Cartesian products, bounded sum and difference t-norms and t-co-norms. **(12L+3T)**

Unit II: Extension principle- The Zadeh's extension principle, image and inverse image of fuzzy sets, fuzzy numbers and elements of fuzzy arithmetic of fuzzy sets. **(12L+3T)**

Unit III: Fuzzy relations and fuzzy graphs-Fuzzy relations on fuzzy sets, compostion of fuzzy relations, min-max composition and its properties, fuzzy equivalence relations, Fuzzy compatibility relations, Fuzzy relations equations, Fuzzy graphs, similarity relations.**(12L+3T)**

Unit IV: Possibility Theory: Fuzzy measure, Evidence Theory, Possibility Theory, Possibility Theory and Fuzzy sets. Fuzzy Logic-an overview of classical logic, multivalued logics, fuzzy propositions, fuzzy quantifiers. **(12L+3T)**

Text Books:

G. J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice-Hall India, New Delhi (1995).

Scope: Chap 1, 2, 3 and 8.

Reference Books:

[1] H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Springer, (2001).

[2] Didier Dubois and Henri Prade, Fuzzy Sets and Systems: Theory and Applications, Academic Press (1980).

MTU-411: Multivariate Calculus

Unit I: Introduction: Level sets and Tangent spaces, Lagrange's multipliers, Maxima & Minima on open sets. **(12L+3T)**

Unit II: Line integral, Frenet-Serret equations, Double Integration parameterized surfaces in R3. , Surface Area, Surface Integral. **(12L+3T)**

Unit III: Stoke's Theorem, Triple integral, The Divergence theorem. **(12L+3T)**

Unit IV: Geometry of surfaces in R3, Gaussian curvatures, Geodesic curvature. **(12L+3T)**

Text Book:
Sean Dineen, Multivariate Calculus and Geometry, Springer Verlag.

Scope: Chapters 1 to 18.

Reference Books:

1. Sudhir R. Ghorpade and Balmohan V. Limaye, "A course in Multivariate Calculus and Analysis", Springer Verlag.
2. T. M. Apostol, "Calculus", Vol. 2, Second Edition, John Wiley and Sons, Inc.
3. J. A. Thorpe, "Elementary Topics in Differential Geometry", Springer Verlag.
4. Devinatz, "Advanced Calculus".
5. B. Oneill, Elementary Differential Geometry.
6. J. E. Marsden, A. J. Tromba, A. Weinstein, Basic Multivariable Calculus, Springer Internationsl Edition, Springer Verlag.