KANNUR UNIVERSITY

(Abstract)

Revised Scheme, Syllabus and Model Question Papers of M.Sc. Mathematics Programme (CBCSS) - implemented in the University Department - w.e.f. 2020 Admission – Orders issued.

ACADEMIC C SECTION

Acad/C4/13135/2020 Dated: 20.01.2021

Read:-1.Minutes of the meeting of the Syndicate held on 26.10.2019, vide item No. 2019.676

2. U.O.No.ACAD C3/22373/2019. dated 08.10.2020

3. U.O.No.Acad/C3/22373/2019, dated 12.11.2020

4. The Minutes of the meeting of the Department Council, Dept. of Mathematical Sciences dated 11.01.2021

5. Letter dated 12.01.2021, from the Head, Dept. of Mathematical Sciences along with revised Scheme, Syllabus and Model Question Papers of M.Sc. Mathematics Programme

ORDER

1. The meeting of the Syndicate held on 26.10.2019 resolved vide paper read (1) above to revise the Scheme and Syllabus of all Post Graduate Programmes under Choice Based Credit Semester System (CBCSS) in the Schools/Departments of University with effect from 2020 admission.

2. Subsequently, the Curriculum Committee was reconstituted as per paper read (2) above to monitor and co-ordinate the working of the Choice based Credit Semester System.

3. Accordingly, the revised Regulations for P.G. Programmes under Choice Based Credit Semester System were implemented in the Schools/Departments of the University with effect from 2020 admission as per paper read (3) above.

4. Further, the Department Council, vide paper read (4) above approved the revised Scheme, Syllabus and Model Question papers of the M.Sc. Mathematics Programme, prepared in line with the revised Regulations for Choice Based Credit Semester System, for implementation in the Department of Mathematical Sciences, w.e.f 2020 admission.

5. Subsequently, the revised Scheme, Syllabus & Model Question Papers of M.Sc. Mathematics programme, prepared in line with the revised Regulations for Choice Based Credit Semester System, was duly scrutinized by an External Expert and he recommended the Syllabus for implementation with certain modifications.

6. Thereafter, as per the paper read (5) above, the revised Scheme, Syllabus and Model Question Papers of the M.Sc. Mathematics Programme was forwarded by the Head, Dept. of Mathematical Sciences, Mangattuparamba Campus,with necessary incorporation on the basis of the Expert's opinion, for implementation with effect from 2020 admission.

7. The Vice Chancellor after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11 (1) Chapter III of Kannur University Act 1996 accorded sanction to implement the revised Scheme, Syllabus and Model Question Papers of the M.Sc Mathematics Programme under Choice Based Credit Semester System,in the Department of Mathematical Sciences, Mangattuparamba Campus of the University with effect from 2020 admission, subject to reporting to the Academic Council.

8. The revised Scheme, Syllabus and Model Question Papers of M. Sc Mathematics Programme (CBCSS), implemented with effect from 2020 admission are uploaded in the University Website.**(www.kannuruniversity.ac.in)**.

Orders are issued accordingly.

Sd/-

BALACHANDRAN V K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To: The Head, Dept.of Mathematical Sciences, Mangattuparamba Campus
Kannur - 670567

Copy To: 1. The Examination Branch (through PA to CE).
2. PS to VC / PA to PVC / PA to R / PA to CE
3. DR / AR 1 (Acad).
4. The Computer Programmer (for uploading in the Website)
5. SF / DF /FC

KANNUR UNIVERSITY CIVIL STATION P.O. KANNUR Pin-670 002 THAVAKKARA

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY

DEPARTMENT OF MATHEMATICAL SCIENCES

Choice Based Credit & Semester System (CBCSS)

M.Sc. MATHEMATICS SYLLABUS

(Effective from M.Sc. Admission 2020 onwards)

CONTENTS

1. ABOUT THE DEPARTMENT

The Department of Mathematical Sciences which was started in 2008 at the Mangattuparamba Campus of Kannur University. It was established with a vision to promote quality education and innovative research in Mathematical Sciences in Kerala, especially in the northern part of Kerala. So far 7 students completed Ph.D from this department. Presently 11 research scholars are doing research in the department. The department offers M. Sc. and Ph.D programs in Mathematics. The department has an NBHM funded library ,with more than 3000 volumes of books.

2. INTRODUCTION TO CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

2.1. DEFINITIONS:

(i) **Academic Programme** means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.

(ii) **Course** means a segment of a subject that is part of an Academic Programme.

(iii) **Programme Structure** means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) **Core Course** means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) **Elective Course** means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.

(vi) **Open Elective** means an elective course which is available for students of all programmes including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) **Credit** means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

(viii) **SGPA** means Semester Grade Point Average calculated for individual semester.

(ix) **CGPA** is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together.

2.2. PROGRAMME OBJECTIVES :

The main objective of this program is to provide a quality education and problem solving skills in Mathematics to young minds through teaching and learning process. In addition, the course focuses on laying a strong foundation for quality research in Mathematics and related areas .

2.3. PROGRAMME OUTCOMES :

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

1. Gain sound knowledge in Mathematics.
2. a good researcher/teacher in Mathematics.

3. M.SC. MATHEMATICS PROGRAMME DETAILS

M.Sc. Mathematics programme is a two-year course divided into four-semesters. A student is required to complete 80 credits for the completion of course and the award of degree.

3.1. PROGRAMME STRUCTURE

		Semester	Semester
Part-I	First Year	Semester I	Semester II
Part-II	Second Year	Semester III	Semester IV

COURSE CREDIT SCHEME:

Sem-ester	Core courses			Elective Courses			Open Courses			Disser tation credits	Proje ct/Viv a voce credit s	Total credits
	No. of Papers	Credit (L+T+P)	Total Credits	No. of Papers	Credits (L+T+P)	Total Credit s	No. of Papers	Credit s (L+T +P)	Total Credit s			
I	**5**	**18+0+0**	**18**	**0**		**0**	**0**		**0**		**2**	**20**
II	**5**	**18+0+0**	**18**	**0**		**0**	**0**		**0**		**2**	**20**

III	**2**	**8 +0+0**	**08**	**1**	**4+0+0**	**4**	**1**	**4+0+0**	**4**	**2**	**2**	**20**
IV	0	**0+0+0**	**0**	**4**	**16+0+0**	**16**	**0**		**0**	**2**	**2**	**20**
			44			**20**			**4**	**4**	**8**	**80**

SEMESTER WISE DETAILS:

SEMESTER -I					
Number of Core Courses: 5					
Sl. No	Course Code	Course Title	Theory	Tutorial	Credits
1	MSMAT01C01	Algebra I	3	0	3
2	MSMAT01C02	Linear Algebra	4	0	4
3	MSMAT01C03	Differential Equations I	3	0	3
4	MSMAT01C04	Real Analysis	4	0	4
5	MSMAT01C05	Topology	4	0	4
6	MSMAT01C06	Viva voce			2
	Total credit in core courses				20
	Number of elective courses: 0				
	Credits in each course		Theory	Tutorial	Credits
	Total credits in elective courses		0	0	0
	Number of open elective courses: 0				
	Total credits in open elective courses		0	0	0
	Total credits in Semester –I				20

SEMESTER –II					
Number of Core Courses: 5					
Sl. No	Course Code	Course Title	Theory	Tutorial	Credits
1	MSMAT02C01	Complex Analysis	4	0	4
2	MSMAT02C02	Functional Analysis I	4	0	4
3	MSMAT02C03	Algebra II	3	0	3
4	MSMAT02C04	Differential Equations II	3	0	3

5	MSMAT02C05	Measure and Integration	4	0	4
6	MSMAT02C06	Viva voce			2
	Total credit in core courses				20
	Number of elective courses: 0				
	Credits in each course		Theory	Tutorial	Credits
	Total credits in elective courses		0	0	0
	Number of open elective courses: 0				
	Total credits in open elective courses		0	0	0
	Total credits in Semester –II				20

SEMESTER –III					
Number of Core Courses: 2					
Sl. No	Course Code	Course Title	Theory	Tutorial	Credits
1	MSMAT03C01	Differential Geometry	4	0	4
2	MSMAT03C02	Functional Analysis II	4	0	4
3	MSMAT03C03	Project/ Dissertation and Viva Voce			4
	Total credit in core courses		08	0	12
	Number of elective courses: 1				
Credits in each course			Theory	Tutorial	Credits
MSMAT03E01/02/03	Elective Course 1		4	0	4
Total credits in elective courses			4	0	4
Number of open elective courses: 1					
MSMAT03O01 To MSMAT03O08	Open elective course		4	0	4
Total credits in open elective courses			4	0	4
Total credits in Semester III				0	20

SEMESTER -IV					
Number of Core Courses: 0					
Sl. No	Course Code	Course Title	Theory	Tutorial	Credits
1	MSMAT04C01	Project/Dissertation and Viva Voce			4
	Total credit in core courses		0	0	4
	Number of elective courses: 4				
Credits in each course			Theory	Tutorial	Credits
MSMAT04E01 to MSMAT04E17	Elective Course 1		4	0	4
MSMAT04E01 to MSMAT04E17	Elective Course 2		4	0	4
MSMAT04E01 to MSMAT04E17	Elective Course 3		4	0	4
MSMAT04E01 to MSMAT04E17	Elective course 4		4	0	4
Total credits in elective courses			16	0	16
Number of open elective courses: 0					
Total credits in open elective courses			0	0	0
	Total credits in Semester IV				20

Selection of Elective Courses:

For selection of open course, a student may choose one course in semester III and four course in semester IV from the lists of options being offered by the department.

Elective courses		
COURSE CODE	COURSE TITLE	L-T-P
MSMAT03E01	Fuzzy Mathematics	4-0-0
MSMAT03E02	Operation Research	4-0-0
MSMAT03E03	Stochastic Process	4-0-0

MSMAT04E01	Algebraic Geometry	4-0-0
MSMAT04E02	Projective Geometry	4-0-0
MSMAT04E03	Advanced Complex Analysis	4-0-0
MSMAT04E04	Analytical Mechanics	4-0-0
MSMAT04E05	Fluid Mechanics	4-0-0
MSMAT04E06	Algebraic Topology	4-0-0
MSMAT04E07	Numerical Analysis and computing	4-0-0
MSMAT04E08	Graph Theory	4-0-0
MSMAT04E09	Fractal Geometry	4-0-0
MSMAT04E10	Coding Theory	4-0-0
MSMAT04E11	Cryptography	4-0-0
MSMAT04E12	Harmonic Analysis	4-0-0
MSMAT04E13	Operator Algebras	4-0-0
MSMAT04E14	Representation Theory of Finite Groups	4-0-0
MSMAT04E15	Number Theory	4-0-0
MSMAT04E16	Analytic Number Theory	4-0-0
MSMAT04E17	Algebraic Number Theory	4-0-0

Open Elective Courses:

Students can join for the open course depending on their choice and availability of seats in the departments offering such courses.

COURSE CODE	COURSE TITLE	L-T-P
MSMAT03O01	Probability Theory	4-0-0
MSMAT03O02	Basic Topology and Modern Analysis	4-0-0

MSMAT03O03	Basic Algebra	4-0-0
MSMAT03O04	Basic Linear Algebra	4-0-0
MSMAT03O05	Basic Differential Equations	4-0-0
MSMAT03O06	Basic Real Analysis	4-0-0
MSMAT03O07	Basic Topology	4-0-0
MSMAT03O08	Applied Fuzzy Topology	4-0-0

Teaching:

The faculty of the Department is primarily responsible for organizing lecture work of M.Sc. Mathematics. There shall be 90 instructional days excluding examination in a semester.

3.2. ELIGIBILITY FOR ADMISSION:

BSc Mathematics with minimum of 50% marks or equivalent grade in core course

RELAXATION & WEIGHTAGE:

As prescribed in the university regulation.

NUMBER OF SEATS -20

MODE OF SELECTION:

The selection will be based on the marks obtained in the entrance test, which is to be conducted by the Kannur University.

3.3. ASSESSMENT OF STUDENTS PERFORMANCE AND SCHEME OF EXAMINATIONS

ATTENDANCE

The minimum attendance required for each Course shall be 60% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination. Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and participation in extra-curricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for Condonation shall repeat the Course along with the subsequent batch.

EVALUATION

There shall be two modes of evaluation - the Continuous Evaluation (CE) and the End Semester Evaluation (ESE). The total mark for each course including the Project shall be divided into 40% for CE and 60% for ESE. Continuous Evaluation includes Assignments, Seminars, periodic written examinations etc. The component wise division of the 40% CE mark are as follows

Theory	
Components	% of marks
Test papers	40% (16 marks)
Tutorial with viva, Seminar presentations, Discussion, Debate etc.	40% (16 marks)
Assignment	20% (8 marks)
Total Internal marks	40

The ESE shall be made based on examinations for each course conducted by Controller of Examinations. as per the common norms under the CCSS. The question paper for ESE for Theory Examinations shall contain three sections. The Question paper should contain minimum 3 questions from each unit and should not contain more than 5 questions from the same unit.. The distribution of the number of questions and marks are given in the following table.

Part	Marks	Number of questions to be answered	Number of questions in the question paper	Type of questions (Level - Bloom's Taxonomy)
A	15	5	6	1 Remembering 2 Understanding
B	15	3	5	6. creating
C	30	3	5	3. Applying 4. Analysing 5. Evaluating

Total	60	11	16	

SCHEME OF END SEMESTER EXAMINATIONS:

SEMESTER - I

Sl. No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSMAT01C01	Algebra 1	3	3hrs	60
2	MSMAT01C02	Linear Algebra	4	3hrs	60
3	MSMAT01C03	Differential equations 1	3	3hrs	60
4	MSMAT01C04	Real Analysis	4	3hrs	60
5	MSMAT01C05	Topology	4	3hrs	60
6	MSMAT01C06	Viva voce	2		30

SEMESTER -II

Sl. No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSMAT02C01	Complex Analysis	4	3hrs	60
2	MSMAT02C02	Functional Analysis 1	4	3hrs	60
3	MSMAT02C03	Algebra II	3	3hrs	60
4	MSMAT02C04	Differential Equations II	3	3hrs	60
5	MSMAT02C05	Measure and Integration	4	3hrs	60
6	MSMAT02C06	Viva voce	2		30

SEMESTER -III

Sl. No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks

1	MSMAT03C01	Differential Geometry	4	3hrs	60
2	MSMAT03C02	Functional Analysis II	4	3hrs	60
3	MSMAT03O01 to MSMAT03O08	Open Elective	4	3hrs	60
4	MSMAT03E01/02/03	Elective Course 1	4	3hrs	60
5	MSMAT03C03	Project/Dissertation and Viva Voce	4	To be evaluated in the end of forth semester after the completion of the project	

SEMESTER -IV

Sl. No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSMAT04E01 to MSMAT04E17	Elective- 2	4	3hrs	60
2	MSMAT04E01 to MSMAT04E17	Elective- 3	4	3hrs	60
3	MSMAT04E01 to MSMAT04E17	Elective -4	4	3hrs	60
4	MSMAT04E01 to MSMAT04E17	Elective - 5	4	3hrs	60
5	MSMAT04 C01	Project/ Dissertation and Viva Voce	4		120

Project work

Each M. Sc. Student has to carry out a research project during third and fourth semesters. The project work should be started in the third semester and should go continuously for the third and fourth semesters. Project work has **8** credits. The project evaluation, comprising of internal (total 80 marks) and external (total 120 marks) will be carried out during fourth semester. The scheme of evaluation of project is as follows.

Total marks : 200

Content : 30% = 60 marks (36 external & 24 internal)

Methodology and presentation : 50% = 100 marks (60 external & 40 internal)

Dissertation Viva-voce : 20 % = 40 marks (24 external & 16 internal)

External project evaluation has to be done by two external examiners

End semester Viva:

End of semesters I and II, there will be a viva voce examination, based on the topics, taught in the respective semesters.

Total Marks : 50 (20 internal & 30 external)

External Viva Voce examination has to be done by two external examiners

3.4 SPAN PERIOD

No students shall be admitted as a candidate for the examination for any of the Years/Semesters after the lapse of 4 years from the date of admission to the first year of the M.A./M.Sc. programme.

3.5 CONVERSION OF MARKS INTO GRADES

An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale. The following table gives the range of marks %, grade points and alphabetical grade.

Range of Marks%	Grade Points	Alphabetical Grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50	0	F

A minimum of grade point 5 (Grade C) is needed for the successful completion of a Course. A student who has failed in a Course can reappear for the End Semester Examination of the same Course along with the next batch without taking re-admission or choose another Course in the subsequent Semesters of the same Programme to acquire the minimum credits needed for the completion of the Programme. There shall not be provision for improvement of CE and ESE.

SGPA means Semester Grade Point Average calculated for individual semester.

3.6 GRADE POINTS.
CUMULATIVE GRADE POINT AVERAGE (CGPA)

Performance of a student at the end of each Semester is indicated by the Grade Point Average (CGPA) and is calculated by taking the weighted average of grade points of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$CGPA = \frac{\text{Sum of (grade points in a course multiplied by its credit)}}{\text{Sum of Credits of Courses}}$$

3.7 CGPA CALCULATION

At the end of the Programme, the overall performance of a student is indicated by the Cumulative

Grade Point Average (CGPA) and is calculated using the same formula given above. Empirical formula for calculating the percentage of marks will be **(CGPA x 10)+5.** Based on the CGPA overall letter grade of the student and classification shall be in the following way.

CGPA	**Overall Letter Grade**	**Classification**
8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
5 and above but less than 5.5	C	Second Class

Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.

A student who fails to complete the Programme/Semester can repeat the full Programme/ Semester once, if the Department Council permits to do so.

4.

COURSE WISE CONTENT DETAILS FOR M.Sc. MATHEMATICS PROGRAMME.

4.1 The detailed syllabus – Core courses.

MSMAT01C01 ALGEBRA - I

Course Objective: To gain knowledge in basic group theory and ring theory which are essential for further study.
Course Learning outcome: After successful completion of the course, student will be able to understand the basic algebra- group theory and ring theory .

Unit 1

Direct products and finitely generated abelian groups. Homomorphisms a,Factor groups. Factor group computations and simple groups. (Chapter 2 Section11 and Chapter 3 Sections 13-15 of Text .)

Unit 2

Group Action on a set,Application of G-sets to counting,Sylow theorems,Applications of the Sylow theory. Free abelian groups. (Chapter 3 Section16,17 and Chapter 7 Sections 36,37,38 of Text)

Unit 3

Free groups. Group presentation. The Field of quotients of an integral domain. Ring of polynomials. (Chapter 7 Sections 39-40, Chapter 4 Sections 21,22 of Text .)

Unit 4

Factorisation of polynomials over a field. Homomorphisms and factor rings. Prime and maximal ideals. (Chapter 4 Section 23; Chapter 5Sections 26,27 of Text .)

Text Books:

1. J. B. Fraleigh – A First Course in Abstract Algebra- Narosa (7th edn., 2003)

Reference: 1. I.N. Herstein – Topics in Algebra- Wiley Eastern
2. J.A.Gallian – Contemporary Abstract Algebra
3. Hoffman & Kunze – Linear Algebra – Prentice Hall
4. M. Artin, Algebra, Prentice Hall, 1991

MSMAT01C02 LINEAR ALGEBRA

Course Objective: Linear transformations and its connections to matrices , inner product spaces are discussed which are essential to learn Functional Analysis.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic linear algebra- vector space, linear transformations and inner product spaces.

Unit 1

Linear Transformations: Linear Transformations, The Algebra of Linear Transformations, Isomorphism, Representation of Transformation by Matrices, (Chapter-3; Sections 3.1, 3.2,3.3, 3.4,)

Unit 2

Linear Functionals, The Double Dual, The Transpose of a Linear Transformation.
Elementary Canonical Forms: Introductions, Characteristic Values
(Chapter 3, sections 3.5, 3.6, 3.7 Chapter-6: Section 6.1, 6.2,)

Unit 3

Annihilating Polynomials ,Invariant Subspace, Simultaneous Triangulations& Simultaneous Diagonalisation.

Elementary Canonical Forms: Invariant Direct Sums,
(Chapter-6: Sections 6.3, 6.4, 6.5, 6.6 6.7)

Unit 4

The Primary Decomposition Theorem.
The Rational and Jordan Forms: Cyclic Subspaces and Annihilators, Cyclic Decomposition and the Rational Forms

Inner Product Spaces: Inner Products, Inner Product Spaces, (Chapter 6 section 6.8; Chapter-7: Sections: 7.1, 7.2, Chapter-8: Sections 8.1, 8.2,)

Text Book: Kenneth Hoffman & Ray Kunze; Linear Algebra; Second Edition, Prentice-Hall of India Pvt. Ltd

Reference:

1. Serge A Lang: Linear Algebra; Springer
2. Paul R Halmos Finite-Dimensional Vector Spaces; Springer 1974.
3. McLane & Garrell Birkhoff; Algebra; American Mathematical Society 1999.
4. Thomas W. Hungerford: Algebra; Springer 1980
5. Neal H.McCoy & Thomas R.Berger: Algebra-Groups, Rings & Other Topics: Allyn & Bacon.

MSMAT01C03 DIFFERENTIAL EQUATIONS - 1

Course Objective: To gain knowledge on the basic differential equations at the heart of analysis which is a dominant branch of mathematics for 300 years. This subject is the natural purpose of the primary calculus and the most important part of mathematics for understanding physics.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of differential equations and the method of solving them .

Unit 1

Existence and Uniqueness of solutions of differential equations.
Oscillation theory (Chapter 13 sections 68 , 69and 70, Chapter 4 complete)

Unit 2

Power series solutions and special functions.(excluding section 26),
Series solutions of first order equations, Second order linear equations,
Regular singular points, Gauss's hyper geometric equation, point at infinity (Chapter 5, Section 27-32)

Unit 3

Legendre polynomials and their properties , Bessel function and their properties. Application of Legendre polynomial to potential theory, Systems of first order equations: linear systems, homogeneous linear system with constant coefficients and nonlinear systems (Chapter 8, Sections 44-47, Appendix A and Chapter 10 sections 54-56)

Unit 4

Nonlinear equations: Autonomous systems, Th phase plane and its phenomina, Types of critical points , stability, Critical points and stability for linear systems, Stability by Liapunov's direct method, simple critical points of nonlinear systems (Chapter 11, Sections 58-62)

Text: George F. Simmons – Differential Equations with applications and

historical notes. Tata McGraw Hill, 2003
References:
1. Birkhoff G &G.C. Rota – Ordinary Differential Equations – Wiley
2. E.A. Coddington – An introduction to Ordinary Differential Equations – Prentice Hall India
3. Chakrabarti – Elements of Ordinary Duifferential Equations & Special Functions – Wiley Eastern
4. A. K. Nandakumaran, P.S Datti, Raju K . George
Ordinary Differential Equations: Principles and Applications, Cambridge IISc Series , 2017

MSMAT01C04 REAL ANALYSIS

Course objective: The aim of this course is to develop basic concepts like limit, convergence, differentiation and Riemann integral. Convergence of functions.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic real analysis- convergence, differentiation and integration .

Unit 1

Basic Topology-Finite,Countable and uncountable Sets Metric spaces, Compact Sets ,Perfect Sets, Connected Sets.
Continuity-Limits of function, Continuous functions, Continuity and compactness, continuity and connectedness, Discontinuities, Monotonic functions, Infinite limits and Limits at infinity.

Unit 2

Differentiation, Derivative of a real function. Mean value theorems, Continuity of derivatives. L Hospital's rule. Derivatives of higher order. Taylor's theorem. Differentiation of vector valued functions

Unit 3

Reimann – Stieltjes integral. Definition and existence of the integral. Integration and differentiation. Integration of vector – valued functions. Rectifiable curves.

Unit 4

Sequences and series of functions. Uniform convergence. Uniform convergence and continuity. Uniform convergence and differentiation.
Equicontinuous families of functions. Stone – Weierstrass theorem.
.

Text: Walter Rudin – Principles of Mathematical Analysis (3rd edition) – Mc Graw Hill, Chapters 2, 4, 5, 6, and 7 (up to and including 7.27 only)

References:

1. T.M. Apostol – Mathematical Analysis (2nd edition) – Narosa

.

2. B.G. Bartle – The Elements of Real Analysis – Wiley International
3. G.F. Simmons – Introduction to Topology and Modern Analysis – McGraw Hill
4. Pugh**,** Charles Chapman**:** Real Mathematical Analysis, springer ,2015.

5. **Sudhir R. Ghorpade , Balmohan V. Limaye, A Course in Calculus and Real Analysis (Undergraduate Texts in Mathematics) , springer, 2006**

MSMAT01C05 TOPOLOGY

Course Objective: To present an introduction to the theory of topology, a powerful tool for understanding other branches of mathematics.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic topology- topological spaces, continuous functions, connected spaces and compact spaces .

Unit 1

Topological spaces, Basis for a topology, The order topology, The product topology (finite), The subspace topology, Closed sets and limit points,
(sections 12 to 17)

Unit 2

Continuous functions, The product topology, The metric topology, The metric topology (continued), The quotient topology (Sections 18-22)

Unit 3

Connected spaces, Connected subspace of the real line,
Compact spaces, compact subset of the real line (sections 23, 24, 26, 27)

Unit 4

The countability axioms, The separation axioms, Normal spaces, The Urysohn lemma, The Urysohn metrization Theorem (without proof), Tietze extension Theorem (without proof), The Tychonoff theorem (without proof). (sections 30, 31, 32, 33, 34, 35, 37)

Text: J.R. Munkres – Topology, Pearson India, 2015.

References:

1. K.D. Joshi – Introduction to General Topology, New age International (1983)
2. G.F. Simmons–Introduction to Topology & Modern Analysis–McGrawHill
3. Singer and J.A. Thorpe – Lecture Notes on Elementary Topology and Geometry, Springer Verlag 1967
4. Kelley J.L. – General Topology, von Nostrand
5. Stephen Willard – General Topology, Dover Books in Mathematics.

MSMAT02C01 COMPLEX ANALYSIS

Course Objective: This course provides an introduction to complex analysis which is the theory of complex functions of a complex variable. The concepts like the complex plane, along with the algebra and geometry of complex numbers, differentiation, integration, Cauchy's theorem, power series representation , Laurent series, residues and some properties of harmonic functions are discussed.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of the theory of analytic functions.

Unit 1

The spherical representation, Conformality - Arcs and closed curves, analytic functions in regions, conformal mapping , length and area - Linear transformations- the linear group, the cross ratio, symmetry, oriented circles, families of circles, Elementary conformal mapping-use of level curves, a survey of elementary mappings and Riemann surfaces (Chapter 1 section 2.4, Chapter 3, Sections 2,3,4)

Unit 2

Complex integration- Fundemental theorems, line integals, rectifiable arcs, Cauchy's theorem for rectangle and disc, Cauchy's integral formula- the index of a point with respect to a closed curve, the integral formula, higher derivatives ,Local properties of analytic functions - removable singularities, Taylor's theorem Zeroes and poles local mapping, , the maximum principle (Chapter 4, Sections 1,2,3)

Unit 3

The general form of cauchy's theorem, Chains and cycles, simple connectivity, homology, general form of Cauchy's theorem, proof of Cauchy's theorem, Locally exact differentials, multiply connected regions , The calculus of residues – the residue theorem, the argument principle , evaluation of definite integrals (Chapter 4, Section 4,5)

Unit 4

Harmonic functions- definition and basic properties, the mean value property, Poisson formula, Schwarz theorem (without proof), the reflection principle(without proof), Power series expansions -Weierstrass theorem, the Taylor series and the Laurent series (Chapter 4, Sections 6 and Chapter 5 section 1)

Text: L.V.Ahlfors – Complex Analysis (3rd edition) – McGraw Hill International (1979)

References:

1. Conway J.B. – Functions of One Complex Variable – Narosa

2. E.T.Copson – An Introduction to the Theory of Complex Variables – Oxford

3. S Lang : Complex Analysis, Fourth Edition, Grauate texts in Mathematics 103, Springer, Second Indian Reprint 2013.

4. Herb Silverman Complex Variabies,Houghton Mifflin Co., 1975.

5. Kunhiko Kodaidra, Complex Analysis, Cambridge studies in Advanced Mathematics 107, 2007

6. Rolf Nevanlinna & Veikko Paatero, Introduction to complex analysis, Second edition, AMS Chelsea Publishing, Indian edition 2013.

MSMAT02C02 FUNCTIONAL ANALYSIS I

Course Objective : The aim of the course is to the study some of the features of bounded operators in Banach spaces and Hilbert spaces. Discusses the fundamental results like Hahn- Banach Theorem, Closed graph Theorem, Open mapping Theorem and their consequences .

Course Learning outcome : After successful completion of the course, student will be able to understand the basic functional analysis- fundamentals of Banach spaces and Hilbert spaces.

Unit 1

Vector space, Normed space, Banach space, Further Properties of Normed spaces, Finite dimensional normed spaces and subspaces, compactness and finite dimension, linear operators, Bounded and continuous linear operators, linear functionals (Section 2.1 to 2.8)

Unit 11

Linear operators and functionals on finite dimensional spaces, normed spaces of operators. Dual space, (upto 2.10.6) , Inner Product spaces. Hilbert spaces, Further properties of inner product spaces, Orthogonal complements and direct sums, Orthonormal sets and sequences, series related to orthonormal sequences and sets (Definitions and statement of results), total orthonormal sets and sequences (upto 3.6.4), Legendre, Hermite and Laguerre Polynomials (Definitions), (Section 2.9 to 3.7).

Unit 111

Representation of Functionals on Hilbert spaces, Hilbert-Adjoint operator, Self adjoint, unitary and normal operators, Zorn's lemma, Hahn-Banach theorem, Hahn-Banach theorem for complex vector spaces and normed spaces, Application to bounded linear functional on C[a,b] (Definitions and statement of results), (section 3.8 to 4.4)

Unit IV

Adjoint operator, Reflexive spaces (Definitions and statement of Results), Category Theorem, Uniform Boundedness Theorem(4.7.1-4.7.3) , Strong and weak convergence , Open mapping theorem, closed linear operators, closed graph theorem.(sections 4.5 to 4.8.3, 4.12 to 4.13)

Text : E. Kreyszig, Introductory Functional Analysis with Applications (Wiley)

REFERENCES

1. B.V. Limaye – Functional Analysis (3rd edition) – New Age International, 2014.

2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

3. M.Thamban Nair, Functional Analysis: A First Course, PHI, 2014.

4. R. Bhatia. : Notes on Functional Analysis TRIM series, Hindustan Book Agency, 2009

5. Kesavan S, : Functional Analysis TRIM series, Hindustan Book Agency, 2009

6. 6 . George Bachman & Lawrence Narici : Functional Analysis , Dover books on mathematics (1966, 2000)

7. Yuli Eidelman, Vitali Milman,and Antonis Tsolomitis, : Functional analysis An Introduction . Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.

MSMAT02C03 ALGEBRA- II

Course Objective: The aim of this course is to learn the Galois Theory.

Course Learning outcome: After successful completion of the course, student will be able to understand some topics in algebra, including Galois theory .

Unit 1

Unique factorization domains, Euclidean domains; Gaussian integers and multiplicative norms. (Chapter 9 Sections 45,46,47 of Text 1.)

Unit 2

Introduction to extension fields. Algebraic extensions. Geometric constructions. (Chapter 6 Sections 29, 31, 32.)

Unit 3

Finite fields. Automorphisms of fields ,The isomorphism extension theorem,. splitting fields (Chapter 6 Section33, Chapter 10 Sections 48,49,50 of Text 1.)

Unit 4

splitting fields, separable extensions, Totally inseparable extensions , Galois theory, Illustrations of Galois theory (Chapter 10 Section 51,52,53,54)

Text Books:

1. Fraleigh – A First Course in Abstract Algebra- Narosa (7th edn.), 2003

Reference:

1. J.A.Gallian – Contemporary Abstract Algebra
2. Hoffman & Kunze – Linear Algebra – Prentice Hall
3. P.B. Bhattacharya, S.K. Jain, S.R. Nagpal – Basic Abstract Algebra
4. M. Artin – Algebra, Prentice Hall, 1991

MSMAT02C04 DIFFERENTIAL EQUATIONS - II

Course Objective : The main aim of the course is to familiarize the students with the fundamental concepts of Partial Differential Equations (PDE) .

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of partial differential equation and the method of solving them .

Unit 1

First order partial differential equations (PDE): Curves and surfaces, Genisis of first order PDE, classification of integrals, linear equations, Pfaffian equations, compatible systems, Charpit's Method, Jacobi's method. (Chapter 1 Sections 1.1 to1.8)

Unit 2

Integral surfaces through a given curve, Quasilinear equations, nonlinear equations Genesis and classification of second order PDE (Chapter 1 Sections 1.9,1.10,1.11 and sections 2.1,2.2 of chapter 2)

Unit 3

Second order equations: classification, one-dimensional wave equation and Laplace’s equation (Sections 2.3 and 2.4 of Chapter 2)

Unit 4

Heat conduction problem, Duhamel’s principle, families of equipotential surfaces, Kelvin’s inversion theorem (Chapter 2 Sections 2.5,2.6,2.8,2.9)

Text : Amaranath – An elementary course in partial differential equations (2nd edition) – Narosa Publishing House, 2003

References:

1. A. K. Nandakumaran, P. S. Datti; Partial Differential equations : Classical Theory with a Modern Touch, Cambridge University Press, 2020

4 Ian Sneddon – Elements of partial differential equations, McGraw Hill, 1983

5 Phoolan Prasad and Renuka Ravindran – Partial differential equations, New Age

MSMAT02C05 MEASURE AND INTEGRATION

Course Objective: The main aim is to get a clear picture of the abstract measure theory and Lebesgue integral, which is essential for the study of advanced analysis.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic measure theory, integration and convergence theorems .

Unit 1

Introduction. Measurable functions. Measures.

Unit 2

The integral. Integrable functions. Lp – spaces.

Unit 3

Modes of convergence.

Unit 4

Generation of measures. Decomposition of measures.

Text: R.G. Bartle – The Elements of Integration (1966), John Wiley & Sons (Complete Book)

References: 1. H.L. Royden – Real Analysis –Macmillan
2. de Barra – Measure and Integration
3. Inder K. Rana – Measure and Integration – Narosa

MSMAT03C01 DIFFERENTIAL GEOMETRY

Course Objective: The course gives an introduction to the elementary concepts of differential geometry using the calculus of vector fields so that the students also attain a deep understanding of several variables calculus.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of differential geometry and several variable calculus.

Unit 1

Level sets, vector fields, tangent spaces, surfaces, orientation, Gauss map.

Unit 2

Geodesics, parallel transport, Weingarten map, curvature of plane curves

Unit 3

Arc length, line integrals, curvature of surfaces.

Unit 4

Parametrized surfaces. Local equivalence of surfaces and parametrized surfaces.

Text Book: J. A. Thorpe – Elementary Topics in Differential Geometry, Springer-Verlag, Chs.1-12, 14 and 15.

References:

1. Guillemine & Pollack – Differential Geometry, Prentice Hall
2. Struik D.J. – Classical Differential Geometry – Dover (2nd edn.) (1988)
3. Kreyszig, E. – Introduction to Differential Geometry and Riemannian Geometry – Univ. of Toronto Press (1969)

4. M. Spivak – A Comprehensive Introduction to Differential Geometry Vols. 1-3, Publish or Perish Boston (3rd edn.) (1999)

MSMAT03C02 FUNCTIONAL ANALYSIS - II

Course Objective : The aim of the course is to study the spectral theory of compact linear operators and bounded self adjoint linear operators.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic operator theory which leads to spectral theorem .

Unit 1

Approximation in normed spaces, Uniqueness, strict convexity, Approximation in Hilbert space, Spectral Theory in finite dimensional normed spaces , Basic concepts, Spectral properties of bounded linear operators, (section , 6.1 , 6.2, 6.5 , 7.1 ,7.2, 7.3)

Unit 11

Further properties of resolvent and spectrum, Use of complex analysis in spectral theory, Banach algebras, Further properties of Banach algebras, compact linear operators on normed spaces, Further properties of compact linear operators (7.4 to 8.2)

Unit 111

Spectral properties of compact linear operators on normed spaces, Further spectral properties of compact linear operators, spectral properties of bounded self adjoint linear operators, further spectral properties of bounded self adjoint linear operators, Positive operators, square root of a positive operator, (section 8.3 to 8.4 & 9.1 to 9.4)

Unit IV

Projection operators, further properties of projections, spectral family, spectral family of a bounded self adjoint linear operators, spectral representation of bounded self adjoint linear operators. (sections 9.5 to 9.9.1)

Text : E. Kreyszig, Introductory Functional Analysis with Applications (Wiley)

REFERENCES

1. B.V. Limaye – Functional Analysis (3rd edition) – New Age International, 2014.

2. M.Thamban Nair, Functional Analysis: A First Course, PHI, 2014.

3. R. Bhatia. : Notes on Functional Analysis TRIM series, Hindustan Book

Agency, 2009

4 . Sunder V.S, : Functional Analysis spectral theory, TRIM Series, Hindustan Book Agency,1997

5 . George Bachman & Lawrence Narici : Functional Analysis , Dover books on mathematics (1966, 2000)

6 . Yuli Eidelman, Vitali Milman,and Antonis Tsolomitis, : Functional analysis An Introduction, Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.

MSMAT04C01 PROJECT/ DISSERTATION AND VIVA VOCE

To be evaluated in the end of forth semester after the completion of the Project.

4.2 Elective Courses

MSMAT03E01 FUZZY MATHEMATICS

Course Objective: The aim is to provide an introduction to the fundamental concepts of Fuzzy Mathematics.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of fuzzy mathematics.

Unit 1

From classical (crisp) sets to fuzzy sets: characteristics and significance of the paradigm shift. Additional properties of α-cuts. Representation of fuzzy sets. Extension principle for fuzzy sets. (Chs. 1 & 2 of the Text Book)

Unit 2

Operations on fuzzy sets. Types of operations. Fuzzy complements. t-norms, t-conorms. Combinations of operations. Aggregate operations. , Fuzzy numbers Arithmetic operations on intervals. Arithmetic operations on fuzzy numbers. Lattice of fuzzy numbers (Sections

3.1 to 3.4 of Ch. 3 of the Text and sections 4.1 to 4.5)

Unit 3

Crisp and fuzzy relations, projections and cylindric extensions, binary fuzzy relations, binary relations on a single set, Fuzzy equivalence relations , Compatibility and ordering relations. (sections 5.1 to5.6 of chapter 5 of text 5)

Unit 4

Fuzzy morphisms. sup-i, inf- ωicompositions of fuzzy relations. Fuzzy logic. Fuzzy propositions. Fuzzy quantifiers. Linguistic hedges. Inference from conditional, conditional and qualified and quantified propositions (Sections 5.8 to 5.10 of Ch. 5 of the Text, and Ch. 8 of the Text)

Text Book: Fuzzy sets and Fuzzy logic Theory and Applications – G. J. Klir & Bo Yuan – PHI (1995)

References :

1. Zimmermann H. J. – Fuzzy Set Theory and its Applications, Kluwer (1985)
2. Zimmermann H. J. – Fuzzy Sets, Decision Making and Expert Systems, Kluwer (1987)
3. Dubois D. & H. Prade – Fuzzy Sets and Systems: Theory and Applications – Academic Press (1980)

MSMAT03E02 OPERATIONS RESEARCH

Course Objective : Identify and develop the mathematical tools that are needed to solve optimization problems.

Course Learning outcome: After successful completion of the course, student will be able to understand different techniques involved in operations research.

Unit 1

Linear programming in two-dimensional spaces. General LP problem. Feasible, basic and optimal solutions, simplex method, simplex tableau, finding the first basic feasible solution, degeneracy, simplex multipliers. (Chapter 3 Sections 1-15).

Unit 2

The revised simplex method. Duality in LP problems, Duality theorems, Applications of duality, Dual simplex method, summary of simplex methods, Applications of LP. (Chapter 3. Sections 16-22)

Unit 3

Transportation and Assignment problems (Chapter 4)

Unit 4

Integer programming. Theory of games (Chapters 6 and 12)

Text Book: K. V. Mital and C. Mohan – Optimisation Methods in Operations Research and Systems Analysis (3rd edition) -New Age International (1996).

Reference Books:

1. Wagner – Operations Research, Prentice Hall India
2. A. Ravindran, Don T. Philips, James Solberg – Operations Research, Principles and Practice – John Wiley (3rd edition)
3. G. Hadley – Linear Programming – Addison Wesley
4. Kanti Swarup, P.K.gupta, Man Mohan – Operations Research – S. Chand & Co.

MSMAT03E03 STOCHASTIC PROCESSES

Course Objective: The aim is to provide an introduction to the fundamental concepts of stochastic process.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of stochastic process .

Unit 1

A brief description of Markov Process, Renewal Process, Stationary Process. Markov Chains: n-step transition probability matrix, classification of states, canonical representation of transition probability matrix, finite Markov chains with transient states. Irreducible Markov Chains with ergodic states: Transient and limiting behaviour.

Unit 2

First passage and related results. Branching Processes and Markov chains of order larger than 1, Lumpable Markov Chains, Reversed Markov Chains.

Unit 3

Applied Markov Chains: Queuing Models, Inventory Systems, Storage models, Industrial Mobility of Labour,, Educational Advancement, Human Resource Management, Term Structure, Income determination under uncertainty, Markov decision process. Markov

Processes: Poisson and Pure birth processes, Pure death processes, Birth and death processes, Limiting distributions.

Unit 4

Markovian Networks. Applied Markov Processes: Queueing models, Machine interference problem, Queueing networks, Flexible manufacturing systems, Inventory systems, Reliability models, Markovian Combat models, Stochastic models for social networks; Recovery, relapse and death due to disease.

Text book: U.N. Bhat and Gregory Miller: Elements of Applied Stochastic Processes, Wiley Interscience, 2002 (Chs. 1, 2, 3, 4, 6, 7, 9.1-9.4, 9.9 and 10)

References:

1. Karlin and Taylor: A First Course in Stochastic Processes, Academic Press, 1975
2. E.Parzen: Stochastic Processes, Wiley 1968.
3. J.Medhi: Introduction to Stochastic Processes, New Age International Publishers, 1994, Reprint 1999.

MSMAT04E01 ALGEBRAIC GEOMETRY

Course Objective: The purpose of this course is to explain the basic principles of algebraic geometry.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics algebraic geometry..

Unit 1

Affine algebraic varieties. The Zariski topology. Morphisms. Dimension. Hilbert basis theorem. Hilbert Nullstellensatz. The co-ordinate ring. The spectrum of a ring.

Unit 2

Projective space. Projective varieties. Projective closure. Morphisms of projective varieties. Automorphisms of projective space. Quasi-projective varieties. A basis for the Zariski topology. Regular functions.

Unit 3

Classical constructions.

Unit 4

Smoothness. Bertini's theorem. The Gauss mapping.

Text book: An invitation to Algebraic Geometry – K. Smith, L. Kahanpaa, P. Kekalainen and W. Treves, Springer (2000) relevant portions of Chapters 1 to 7.

References:

1. Undergraduate Commutative Algebra – Miles Reid, Cambridge Univ. Press. (1995)
2. Introduction to Commutaive Algebra – M. F. Atiyah & I. G. MacDonald – Addison-Wesley (1969)
3. Algebraic Geometry – Keith Kendig – Springer
4. Undergraduate Algebraic Geometry – Miles Reid, Cambridge Univ. Press (1988)
5. Hartshorne, R. – Algebraic Geometry, Springer-Verlag (1977)
6.Shafarevich I. R. – Basic Algebraic Geometry, Springer-Verlag (1974)

MSMAT04E02 PROJECTIVE GEOMETRY

Course Objective: The course discusses some important concepts of Projective Geometry and provides the logical foundations, including the famous theorems of Desargues and Pappus and the theory of conics.

Course Learning outcome: After successful completion of the course, student will be able to understand the foundations of projective geometry.

Unit 1

What is Projective Geometry? Projectivities. Perspectivities. Triangles and quadrangles: axioms and simple consequences. Perspective triangles. Quadrangular sets. Harmonic sets. The principle of duality. The Desargues' configuration. The invariance of the harmonic relation. .Trilinear polarity. Harmonic nets..

Unit 2

The fundamental theorem and Pappus' theorem: The axis of a projectivity. Pappus and Desargues. One-dimensional projectivities. Superposed ranges. Parabolic projectivities. Involutions and hyperbolic involutions. two dimensional projectivities. Projective, perspective and involutory collineations. Projective correlations.

Unit 3

Polariies: Conjugate points and conjugate lines. polar triangles. The use of self-polar pentagon. A self-conjugate quadrilateral. Product of two polarities. Self-polarity of the Desargues configuration. The conic. The polarity induced by a conic. Projectivity related pencils. Steiner's definition for a conic. The conic touching five given lines. The conic through five given points. Conics through four given points. Degenerate conics.

Unit 4

A finite projective plane. S combinatorial scheme for PG(2,5). Involution. Collineation and correlation conic. Is the circle a conic? Affine space. the language of pencils. The plane at inifinity. Euclidean space.

Text Book:

H.S.M. Coxeter – Projective Geometry (2nd edn.)—Univ. of Toronto Press (1974) . (The whole book).

References:

1. Struik D. J.– Lectures on Analytic and Projective Geometry – Addison-Wesley, 1953
2. Coxeter H. S. M.- The real Projective Plane (1955)

MSMAT04E03 ADVANCED COMPLEX ANALYSIS

Course Objective : The aim of the course is the study some advanced topics in complex analysis like Hadamard's theorem, reflection principle, mean value property, elliptic functions, The Weierstrass ρ-function etc.

Course Learning outcome: After successful completion of the course, student will be able to understand the advanced topics in complex analysis.

Unit 1

Partial fractions. Infinite products. Canonical products. The Gamma function. Stirling's formula. Entire functions. Jensen's fomula. Hadamard's theorem (without proof) (Chapters 5, section 2)

Unit 2

Riemann mapping theorem. Boundary behaviour. Use of reflection principle. Analytic arcs. Conformal mapping of polygons. The Schwarz-Christoffel formula. Mapping on a rectangle. The triangle functions of Schwarz. Functions with mean value property. Harnack's principle (Ch. 6 Sections 1,2,3)

Unit 3

Subharmonic functions. Solutions. Solution of Dirichlet problem . Simply periodic functions. Doubly periodic functions. Unimodular transformations. Canonical basis. General properties of elliptic functions. (Ch. 6 Sections ,4 and Chapter 7 sections 1,2)

Unit 4

The Weierstrass ρ-function. The functions $\zeta(z)$ and $\sigma(z)$. The modular function $\lambda(\tau)$. Conformal mapping by $\lambda(\tau)$. Analytic continuation. Germs and sheaves. Sections and Riemann surfaces. Analytic continuations along arcs. Monodromy theorem.. (Ch. 7, section 3 and Chapter 8 section up to and including 1.6)

Text Book: Ahlfors L. V. – Complex Analysis (3rd edition) McGraw Hill International.

References:

1. Conway J. B. – Functions of one complex variable – Narosa (2002)
2. Lang S.– Complex Analysis – Springer (3rd edn.) (1995)

3. Karunakaran, V. – Complex Analysis – Alpha Science International Ltd. (2nd edn.) 2005.

MSMAT04E04 ANALYTICAL MECHANICS

Course Objective:The aim of the course is to provide a foundation of classical Newtonian Mechanics based on Gaiileo's principie of relativity and Hamilton's principle of least action.

Course Learning outcome: After successful completion of the course, student will be able to understand the fundamentals in analytical mechanics including Galileo's principle of relativity and Hamilton's principle of least action.

Unit 1

Equation of Motion, Conservation Laws

Unit 2

Integration of the equations of motion. Free Oscillation in one dimension

Unit 3

Motion of a rigid body

Unit 4

Hamilton's equations, Routhian, Poisson brackots, Action as a function of the coordinates, Maupertius principles

Text book: L.D. Landau and E.M. Lifshitz-Mechanics (3rd Edition) Porgamon 1976 [Relevant sections of Chapters 1, 2, 3, 5, 21, 6, 7.40 – 7.50]

References:

1.Herbert Goldstein (1980), Classical Mechanics, 2nd Ed., Narosa)
2.N.C. Rana and P.S. Joag (1991), Classical Mechanics, Tata Mc Graw Hill
3. K.C. Gupta (1988), Classical Mechanics of Particles and Rigid Bodies, Wiley Eastern
4.F.R. Gantmacher (1975), Analytical Mechanics, MIR Publishers.

MSMAT04E05 FLUID MECHANICS

Course Objective: The aim of the course is to familiarize the students the study of fluids in motion.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of fluids motion .

Unit 1

Introduction. The continuum hypothesis, volume forces and surface forces, transportation phenomenal, real fluids and ideal fluids. Poperties of gases and liquids. Pressure and thrust. Kinematics of the flow. Differentiation following the motion of the fluid. Velocity of a fluid at a point. Lagrangian and Eulerian description. Acceleration. Equation of continuity, stream lines and path lines.

Unit 2

Equation of motion of an ideal fluid. Euler's equation of motion. Bernoulli's equation, surface condition, velocity potential. Irrotational and rotational motion.

Unit 3

Particular method and applications. Motion in two dimensions, stream function, complex potential. Sources and sinks, Doublets. Images, conformal transformation and its application in Fluid Mechanics. Elements of vortex motion. vorticity and related theorems, line vortices, vortex street. Karman vortex street. Helmholtz theorems on vorticity.

Unit 4

General theory of irrotational motion. Flow and circulation, constancy of circulation. Minimum kinetic energy. Motion of cylinders. Forces on a cylinder, Theorem of Blasius, Theorems of Kutta and Joukowski. Axi-symmetric flows. Stokes stream function, motion of sphere.

.**Text Books:** 1.Frank Chorlton – A Text Book of Fluid Dynamics – ELBS and Van Nostrand (1967) Chs. 2-5 .

2. R. von Mises and K. O. Friedricks – Fluid Dynamics – Springer Verlag (1971)

Reference Books:

1) Davies – Modern Developments in Fluid Mechanics vol I & II – Van Nostrand
2) W.H.Besant and A.R.Ramsey – A Treatise on Hydromechanics Part II – ELBS
3) L.M.Milne Thomson – Theoretical Hydrodynamics Mac Millan (1962)

MSMAT04E06 ALGEBRAIC TOPOLOGY

Course Objective:

The course discusses simplicial homology theory, the Euler Poincare theorem and the fundamental group. The purpose of this course is to give students the opportunity to see how algebraic concepts or abstract algebra can be used as a tool to learn topology, another branch of mathematics.

Course Learning outcome: After successful completion of the course, student will be able to understand the concepts like fundamental groups and covering spaces.

Unit 1

Geometric complexes and polyhedra. Orientation of geometric complexes.

Unit 2

Simplicial homology groups. Structure of homology groups. The Euler-Poincare theorem. Pseudomanifolds and the homology groups of Sn.

Unit 3

Simplicial approximation. Induced homomorphisms on homology groups. Brouwer fixed point theorem and related results.

Unit 4

The fundamental groups. Examples. The relation between H1(K) and π1(|K|).

Text Book: Fred H. Croom – Basic Concepts of Algebraic Topology – Springer Verlag (1978)

References:

1) Maunder – Algebraic Topology – Van Nostrand-Reinhold (1970)
2) Munkres J.R. – Topology, A First Course – Prentice Hall (1975)

MSMAT04E07 NUMERICAL ANALYSIS AND COMPUTING

Course Objective: The aim is to provide an introduction to the fundamental

concepts of numerical analysis and computing.

Course Learning outcome: After successful completion of the course, student will be able to understand different methods of finding numerical solutions of a system of equations .

Unit 1

1 Principles of Numerical Calculations

1.1 Common Ideas and Concepts, Fixed-Point Iteration, Newton's Method, Linearization and Extrapolation, Finite Difference Approximations,

1.2 Some Numerical Algorithms, Solving a Quadratic Equation, Recurrence Relations. Divide and Conquer Strategy.

1.3 Matrix Computations, Matrix Multiplication, Solving Linear Systems by LU Factorization, Sparse Matrices and Iterative Methods, Software for Matrix Computations.

1.4 The Linear Least Squares Problem, Basic Concepts in Probability and Statistics, Characterization of Least Squares Solutions, The Singular Value Decomposition, The Numerical Rank of a Matrix

1.5 Numerical Solution of Differential Equations, Euler's Method , Introductory Example, Second Order Accurate Methods.

Unit 2

2. How to Obtain and Estimate Accuracy

2.1 Basic Concepts in Error Estimation, Sources of Error, Absolute and Relative Errors, Rounding and Chopping.

2.2 Computer Number Systems, The Position System, Fixed- and Floating-Point Representation, IEEE Floating-Point Standard.,Elementary Functions, Multiple Precision

2.3 Accuracy and Rounding Errors, Floating-Point Arithmetic, Basic Rounding Error Results, Statistical Models for Rounding Errors, Avoiding Overflow and Cancellation.

Unit 3

3. Interpolation and Approximation

3.1 The Interpolation Problem, Bases for Polynomial Interpolation, Conditioning of Polynomial

3.2 Interpolation Formulas and Algorithms, Newton's Interpolation ,Inverse Interpolation, Barycentric Lagrange Interpolation, Iterative Linear Interpolation, Fast Algorithms for Vandermonde Systems, The Runge Phenomenon

3.3 Generalizations and Applications, Hermite Interpolation, Complex Analysis in Polynomial Interpolation, Rational Interpolation, Multidimensional Interpolation.

3.4 Piecewise Polynomial Interpolation, Bernštein Polynomials and Bézier Curves, Spline Functions, The B-Spline Basis, Least Squares Splines Approximation. The Fast Fourier Transform. The FFT Algorithm.

Unit 4

4. Numerical Integration

4.1 Interpolatory Quadrature Rules ,Treating Singularities, Classical Formulas, Super-convergence of the Trapezoidal Rule, Higher-Order Newton–Cotes' Formulas

4.2 Integration by Extrapolation , The Euler–Maclaurin Formula, Romberg's Method, Oscillating Integrands Adaptive Quadrature

Text Books:

1. Numerical Analysis in Scientific Computing (Vol.1) Germund Dahlquist, Cambridge University press)
2. Numerical Recipes in C – The art of scientific computing (3rd edn.)(2007) – William Press (also available on internet)

Reference Books:

1. Applied Numerical Analysis using MATLAB. (2nd Edn) Laurene Fausett (Pearson)
2. Numerical Analysis: Mathematics of Scientific Computing, David Kincaid, Chency et.al. , Cengage Learning (Pub), 3rd Edn
3. Deuflhard P. & A. Hofmann – Numerical Analysis in Modern Scientific Computing – Springer (2002).

MSMAT04E08 GRAPH THEORY

Course Objective: Graph Theory related to different branches of mathematics like group theory , topology and combinatorics. This basic course encourage to pursue the students to learn higher mathematics including computer science.

Course Learning outcome: After successful completion of the course, student will be able to understand various topics in graph theory including colouring .

Unit 1

Basic results. Directed graphs. (Chapters I and II of the Text)

Unit 2

Connectivity. Trees (Chs. III and IV)

Unit 3

Independent sets and matchings. Eulerian and Hamiltonian graphs. (Chs. V and VI)

Unit 4

Graph colourings (Ch. VII)

Text Book: R. Balakrishnan, K. Ranganathan – A Text Book of Graph Theory – Springer (2000)

References:

1.C. Berge – Graphs and Hypergraphs – North Holland (1973)
2.J. A. Bondy and V. S. R. Murty – Graph Theory with Applications, Mac Millan 1976
3.F. Harary – Graph Theory – Addison Wesley, Reading Mass. (1969)
4.K. R. Parthasarathy – Basic Graph Theory – Tata McGraw Hill (1994)

MSMAT04E09 FRACTAL GEOMETRY

Course Objective: The aim is to provide an introduction to the fundamental concepts of fractal geometry.

Course Learning outcome: After successful completion of the course, student will be able to understand the fundamentals of fractal geometry.

Unit 1

Mathematical background. Hausdorff measure and dimension (Chapters 1 and 2 except sections 2.4 and 2.5)

Unit 2

Alternate definitions of dimension (Ch. 3)

Unit 3

Local structure of fractals. Projections of fractals (Chs. 5 and 6)

Unit 4

Products of fractals. Intersection of fractals (Chs. 7 and 8)

Text Book:

Frctal Geometry, Mathematical Foundations and Applications by Kenneth Falconer, John Wiley (1990)

Reference:

Mandelbrot B. B. – The Fractal Geometry of Nature – Freeman (1982).

MSMAT04E10 CODING THEORY

Course Objective: The aim is to provide an introduction to the fundamental concepts of coding theory.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic coding theory.

Unit 1

Introduction to Coding Theory. Correcting and detecting error patterns. Weight and distance. MLD and its reliability. Error-detecting codes. Error correcting codes. Linear codes (Chapter 1 of the Text and sections 2.1 to 2.5 of chapter 2 of the text)

Unit 2

Generating matrices and encoding. Parity check matrices. Equivalent codes. MLD for linear codes. Reliability of IMLD for linear codes , Some bounds for codes,Perfect codes , Hamming codes. Extended codes extended Golay code and Decoding of extended Golay code (Sections 2.6 to 2.12 of Chapter 2 and sections 3.1 to 3.6 of chapter 3)

Unit 3

The Golay code, Reed-Muller codes, Fast decoding of RM(1,m) , Cyclic linear codes. Generating and parity check matrices for cyclic codes. Finding cyclic codes. Dual cyclic codes (Sections 3.7 to 3.9 of Chapter .3 and Chapter 4 complete)

Unit 4

. BCH codes. Decoding 2-error-correcting BCH code. Reed-Solomon codes. Decoding (Chapter 5 complete and sections 6.1, 6.2 and 6.3 of chapter 6)

Text Book:

Coding Theory and Cryptography The Essentials (2nd edition) – D. R. Hankerson, D. G. Hoffman, D. A. Leonard, C. C. Lindner, K. T. Phelps, C. A. Rodger and J. R. Wall – Marcel Dekker (2000)

Reference Books:

1.J. H. van Lint – Introduction to Coding Theory – Springer Verlag (1982)

2.E. R. Berlekamp – Algebraic Coding Theory – McGraw Hill (1968)

MSMAT04E11 CRYPTOGRAPHY

Course Objective: The aim is to provide an introduction to the fundamental concepts of Cryptography.

Course Learning outcome: After successful completion of the course, student will be able to understand the fundamentals of cryptography .

Unit 1

Classical cryptography. Some simple cryptosystems. Cryptanalysis (Chapter 1 of the Text)

Unit 2

Shannon's theory (Ch. 2)

Unit 3

Block ciphers and the advanced encryption standard (Ch. 3)

Unit 4

Cryptographic hash function. (Ch. 4)

Text book: Cryptography, Theory and Practice – Douglas R. Stinson – Chapman & Hall (2002)

References:

1. N. Koblitz – A Course in Number Theory and Cryptography (2nd edition) Springer Verlag (1994)
2. D.R.Hankerson etc. – Coding Theory and Cryptography The Essentials – Marcel Dekker

MSMAT04E12 Harmonic Analysis

Course Objective : Many Branches of Mathematics come together In Harmonic Analysis. Each adding richness to the subject and each giving insights Into the subject.. The course is a gentle introduction to Fourier Analysis and Harmonic Analysis.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of Harmonic analysis .

Unit 1

Quick review of chapter 0, The Dirichlet Problem for a Disk, Continuous functions on the unit Disc, The method of Fourier, Uniform convergence, The formulas of Euler, Cesaro convergence, Fejer's theorem, At last the solution. (Chapter 0, sections 1 to 8 , Chapter 0 and 1)

Unit II

Functions on (-pi, pi), Functions on other intervals, Functions with special properties, pointwise convergence of the Fourier series,

(chapter 2,)

Unit III

Normed vector spaces, Convergence in normed spaces, inner product spaces, infinite orthonormal sets, Hilbert spaces, the completion, wavelets. (Chapter 3)

Unit IV

The Fourier transform on Z, Invertible elements in l^1(Z), The Fourier transform on R, Finite Fourier transform. (Chapter 4 sections 1, 2, 3, 6)

Text: Carl L. DeVito, Harmonic Analysis, A gentle Introduction.

Reference Books:

1. Edwin Hewitt; Kenneth A. Ross, Abstract Harmonic Analysis. Springer
2. Yitzhak Katznelson , An Introduction to Harmonic Analysis,
3 Anton Deitmar , A First Course in Harmonic Analysis, springer
    1. Gerald Folland, A course in abstract harmonic analysis
    2. Elias M. Stein and Guido Weiss, Introduction to Fourier Analysis on Euclidean Spaces,

MSMAT04E13 Operator algebras

Course Objective: The objective of this course is to introduce fundamental topics in operator theory. It is a field that has great importance for other areas of mathematics and physics, such as algebraic topology, differential geometry, quantum mechanics. We discuss the basics results of Banach algebras and C* algebras.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of operator algebras- Banach algebras and C*algebras.

Unit I.

Review on Functional analysis , Banach algebras and the invertible group, The spectrum, Multiplicative linear functional, (Sections 1 to 4)

Unit II.

The Gelfand Transform and applications, Examples of maximal ideal spaces, Non-unital Banach algebras, (Sections 5 to 7)

Unit III.

C* algebras, Commutative C* algebras, the spectral theorem and applications, Further applications, Polar Decomposition (Sections 8 to 12)

Unit IV.

Positive linear functional and states, The GNS construction, Non-unital C* algebras, Strong and weak –operator topologies(Sections 13 to 16)

Text: Kehe Zhu, An introduction to operator algebras CRC Press 1993.

Reference Books:

1. Introduction to topology and modern analysis, McGraw Hill Education , 2017
2. R V Kadison and JR. Ringrose: Fundamentals of the theory of Operator algebras , volume 1 , II Academic press, 1983.
3. W. Arveson, An invitation to C* algebras , springer 1998.
4. W. Rudin, Functional analysis, McGraw Hill Education .
5. V S Sunder, An invitation to von Newmann algebras , springer 1998

MSMAT04E14 REPRESENTATION THEORY OF FINITE GROUPS

Objective of the course: The aim of this course is to give an introduction to representation theory . Representation theory is an area of mathematics which studies symmetry in linear spaces. The theory , roughly speaking, is a fundamental tool for studying symmetry by means of linear algebra.

Course Learning outcome: After successful completion of the course, student will be able to understand the representation theory.

No. of credits: 4 Number of hours of Lectures/week : 5

Module - I Introduction, G- modules, Characters, Reducibility, Permutation Representations, Complete reducibility, Schur's lemma. (Sections: 1.1 to 1.7)

Module - II

The commutant (endomorphism) algebra.Orthogonality relations, the group algebra. (section: 1.8 to 2.2)

Module III

,the character table, finite abelian groups, the lifting process, linear characters. (section: 2.3 to 2.6)

Module – IV

Induced representations, reciprocity law, the alternating group A5, Normal subgroups, Transitive groups, the symmetric group, induced characters of S n. (Sections: 3.1 to 3.4 & 4.1 to 4.3)

Text Book : Walter Ledermann, Introduction to Group Characters, Cambridge university press 1087. (Second Edition)

REFERENCES

[1] C. W. Kurtis and I. Reiner, Representation Theory of Finite Groups and Associative Algebras. American Mathematical society 2006.
Algebras, John Wiley & Sons, New York(1962)
2) W **Fulton**, J. **Harris ,Representation Theory, A first course. Springer 2004.**
[2] Fulton, The Representation Theory of Finite Groups, Lecture Notes in Mathematics, No. 682, Springer 1978.
[3] C. Musli, Reprsentations of Finite Groups, Hindustan Book Agency, New Delhi (1993)
[5] J.P. Serre, Linear Reprsentation of Finite Groups, Graduate Text in Mathematics, Vol 42, Springer (1977).

MSMAT04E15 NUMBER THEORY

Course Objective:The aim of the course is to give an introduction to basic concepts of elementary number theory in a combinatorial approach. Both multiplicative and additive problems are discussed.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of number theory-arithmetic functions, distribution of primes and the theory of partitions .

Unit 1

Basic representation theorem. The fundamental theorem of arithmetic; combinatorial and computational number theory: Permutations and combinations, Fermat's little theorem, Wilson's theorem, Generating functions; Fundamentals of congruences- Residue systems, Riffling; Solving congruences- Linear congruences, Chinese remainder theorem, Polynomial congruences.

Unit 2

. Arithmetic functions- combinatorial study of phi (n), Formulae for d (n) and sigma (n), multivariate arithmetic functions, Mobius inversion formula; Primitive roots- Properties of reduced residue systems, Primitive roots modulo p; Prime numbers- Elementary properties of Pi (x), Tchebychev's theorem.

Unit 3

. Quadratic congruences: Quadratic residues- Euler's criterion, Legendre symbol, Quadratic reciprocity law; Distribution of Quadratic residues- consecutive residues and nonresidues, Consecutive ttriples of quardratic residues.

Unit 4

Additivity: Sums of squares- sums of two squares, Sums of four squares; Elementary partition theory- Graphical representation, Euler's partition theorem, Searching for partition identities; Partition generating functions- Infinite products as generating functions, Identities between infinite series and products.

Text Book: George E Andrews: Number Theory, Dover Publications (1971) Chapter1 Section1.2, Chapters 2-13.

References

1. Andre Weil-Basic Number Theory (3rd edn.) Springer-Verlag (1974)

2. Grosswald, E.-Introduction to Number Theory Brikhauser (2nd edition) 1984.

MSMAT04E16 ANALYTIC NUMBER THEORY

Course Objective: The aim is to provide an introduction to analytic number theory. Prime number theorem and Dirichlet's theorem on primes in arithmetic progressions are discussed.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of analytic number theory.

Unit 1

The Fundamental theorem of Arithmetic, Arithmetical functions and Dirichlet multiplications

Unit 2

Averages of arithmetical functions. Some elementary theorems on the distribution of prime numbers.

Unit 3

Congruences. Finite abelian groups and their characters.

Unit 4

Dirichlet's theorem on primes in arithmetic progressions. Periodic Arithmetical Functions and gauss sums

Text Book: Tom M. Apostol- Introduction to Analytic Number Theory (Springer International Edn. 1998) Relevant portions from Chapters 1-8.

References

1. G.H.Hardy & Wright Introduction to Theory of Numbers (Oxford) 1985
2. H.Davenport- The Higher Arithmetic (Cambridge) (6th edn.) 1992.

MSMAT04E17 ALGEBRAIC NUMBER THEORY

Course Objective: The aim is to provide an introduction to the fundamental concepts of algebraic number theory.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of algebraic number theory.

Unit 1

Algebraic background, Symmetric Polynomials, modules, Free abelian groups, Algebraic numbers, Conjugates and discriminants, algebraic integers, integral basis, norms and traces, Rings of integers.(Sections 1.4-1.6, 2.1-2.6 of the text book)

Unit 2

Quadratic fields. Cyclotomic fields. Factorization into irreducible: Historical back ground. Trivial factorization int irreducible (Sections 3.1, 3.2, 4.1-4.3 of the text book)

Unit 3

Examples of non-unique factorization into irreducible. Prime factorization, Euclidean domains, Euclidean quadratic fields. Congruences of unique factorization Ramanajuan-Nagell theorem. (Sections 4.4-4.9 of the text book)

Unit 4

Ideals, Historical background, Prime factorization of ideals. The norm of an ideal. Non-unique factorization in cyclotomic fields. Lattices. The quotient torus. (Sections 5.1-5.4, 6.1, 6.2 of the text book)

Text Book:1.N.Stewart & D.O.Tall-Algebraic Number Theory (2nd edn.) Chapman & Hall (1987)

References:

1. P.Samuel- Theory of Algebraic numbers-Herman Paris Houghton Mifflin (1975)
2. S Lang-Algebraic Number Theory-Addison Wesley (1970)

4.3 <u>Open courses</u>

MSMAT03O01 PROBABILITY THEORY

Course Objective: The course discusses measurability, independence, product spaces, Fubini's theorem and different type of convergences.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of probability- random variables, product spaces and Fubini's theorem

Unit 1

Probability spaces – Dynkin's theorem, construction of probability spaces, measure constructions. (sections 2.1 to 2.6)

Unit 2

Random variables, elements, and measurable maps – inverse maps, measurable maps, induced probability measures, measurability and continuity, measurability and limits, fields generated by maps.(3. Sections 1, 3.2 except 3.2.2, 3.3 and 3.4) Independence – records, ranks, Renyi theorem, groupings, zero-one laws, Borel-Contelli lemma (Sections 4.1 to 4.6)

Unit 3

Integration and expectation – limits and integrals, infinite integrals the transportation theorem and densities, product spaces, independence and Fubini theorem, probability measures on product spaces. (Sections 5.1 to 5.10 except 5.6)

Unit 4

Convergence concepts – almost sure, convergence in probability, quantile estimation, Lp convergence(sections 6.1 to 6.6 except 6.2.1 and 6.4).

Text: Sidney I Resnick – A Probability Path, Birkhauser (1999) (Chapters 2 to 7).

References:

3. K.L. Chung – Elementary Probability Theory, Narosa.
4. W. Feller – Introduction to Probability Theory and Applications volumes & II, John Wiley, 1968
5. A. K. Basu, Measure and Probability, PHI (2004)
6.

MSMAT03O02 BASIC TOPOLOGY AND MODERN ANALYSIS

Course Objective: knowledge of basic analysis and topology is essential to understand the various branches of mathematics, this course is one such.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of real analysis and topology- metric spaces, continuous functions and product spaces.

Unit 1

Sets and set inclusion, The algebra of sets, Functions, Product of sets, Partitions and equivalence relations (sections 1 to 5)

Unit II

countable sets, uncountable sets, Partially ordered sets and lattices,
The definitions and some examples of metric spaces. (Sections 6 to 9)

Unit III.

Open sets, Closed sets, Convergence, completeness and Baire's theorem, continuous mappings, spaces of continuous functions, Euclidean and unitary spaces.
(sections 10 to 15)

Unit IV

The definition and some examples of topological spaces, Elementary concepts, Open bases and open sub bases, weak topologies, The function algebra C(X,R) and C(X,C), Compact spaces, Product spaces (sections 16 to 22)

Text: G F Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill Education , 1963.

References

1. R. G. Bartle and D R Sherbert: Introduction to Real Analysis , 4th edition, John Wiley and Sons, 2010.
2. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill, 1976.

MSMAT03O03 BASIC ALGEBRA

Course Objective: To gain knowledge in basic group theory and ring theory which is essential for the further study.

Course Learning outcome: After successful completion of the course, student will be able to understand the basic group theory and ring theory.

Unit 1

Direct products and finitely generated abelian groups. Homomorphisms a,Factor groups. Factor group computations and simple groups. (Chapter 2 Section11 and Chapter 3 Sections 13-15 of Text .)

Unit 2

Group Action on a set,Application of G-sets to counting,Sylow theorems,Applications of the Sylow theory. Free abelian groups. (Chapter 3 Section16,17 and Chapter 7 Sections 36,37,38 of Text)

Unit 3

Free groups. Group presentation. The Field of quotients of an integral domain. Ring of polynomials. (Chapter 7 Sections 39-40, Chapter 4 Sections 21,22 of Text .)

Unit 4

Factorisation of polynomials over a field. Homomorphisms and factor rings. Prime and maximal ideals. (Chapter 4 Section 23; Chapter 5Sections 26,27 of Text .)

Text Books:

1. J. B. Fraleigh – A First Course in Abstract Algebra- Narosa (7th edn., 2003)

Reference:
1. I.N. Herstein – Topics in Algebra- Wiley Eastern
2. J.A.Gallian – Contemporary Abstract Algebra
3. Hoffman & Kunze – Linear Algebra – Prentice Hall
4. M. Artin, Algebra, Prentice Hall, 1991

MSMAT03O04 BASIC LINEAR ALGEBRA

Course Objective: Linear transformation and its connections to matrices are discussed which is essential to learn Functional Analysis.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of vector spaces, matrices , linear transformations and inner product spaces .

Unit 1
Linear Transformations: Linear Transformations, The Algebra of Linear Transformations, Isomorphism, Representation of Transformation by Matrices, (Chapter-3; Sections 3.1, 3.2,3.3, 3.4,)
Unit 2
Linear Functionals, The Double Dual, The Transpose of a Linear Transformation.
Elementary Canonical Forms: Introductions, Characteristic Values
(Chapter 3, sections 3.5, 3.6, 3.7 Chapter-6: Section 6.1, 6.2,)
Unit 3
Annihilating Polynomials ,Invariant Subspace, Simultaneous Triangulations& Simultaneous Diagonalisation.

Elementary Canonical Forms: Invariant Direct Sums,
(Chapter-6: Sections 6.3, 6.4, 6.5, 6.6 6.7)
Unit 4

The Primary Decomposition Theorem.
The Rational and Jordan Forms: Cyclic Subspaces and Annihilators, Cyclic Decomposition and the Rational Forms

Inner Product Spaces: Inner Products, Inner Product Spaces, (Chapter 6 section 6.8; Chapter-7: Sections: 7.1, 7.2, Chapter-8: Sections 8.1, 8.2,)

Text Book: Kenneth Hoffman & Ray Kunze; Linear Algebra; Second Edition, Prentice-Hall of India Pvt. Ltd

Reference:
1. Serge A Land: Linear Algebra; Springer
2. Paul R Halmos Finite-Dimensional Vector Space; Springer 1974.
3. McLane & Garrell Birkhoff; Algebra; American Mathematical Society 1999.
4. Thomas W. Hungerford: Algebra; Springer 1980
5. Neal H.McCoy & Thomas R.Berger: Algebra-Groups, Rings & Other Topics: Allyn & Bacon.

MSMAT03O05 BASIC DIFFERENTIAL EQUATIONS

Course Objective: To gain knowledge on the basic differential equations at the heart of analysis, a dominant branch of mathematics for 300 years. This subject is the natural purpose of the primary calculus and the most important part of mathematics for understanding physics.

Course Learning outcome: After successful completion of the course, student will be able to understand the method of solving ordinary differential equations .

Unit 1

Existence and Uniqueness of solutions of differential equations. Oscillation theory (Chapter 13 sections 68 , 69and 70, Chapter 4 complete)

Unit 2

Power series solutions and special functions.(excluding section 26), Series solutions of first order equations, Second order linear equations, Regular singular points,Gauss's hyper geometric equation, point at infinity (Chapter 5, Section 27-32)

Unit 3

Legendre polynomials and their properties , Bessel function and their properties. Application of Legendre polynomial to potential theory, Systems of first order equations: linear systems ,homogeneous linear system with constant coefficients and nonlinear systems (Chapter 8, Sections 44-47, Appendix A and Chapter 10 sections 54-56)

Unit 4

Nonlinear equations: Autonomous systems, Th phase plane and its phenomina, Types of critical points , stability, Critical points and stability for linear systems, Stability by Liapunov's direct method, simple critical points of nonlinear systems (Chapter 11, Sections 58-62)

Text: George F. Simmons – Differential Equations with applications and historical notes. Tata McGraw Hill, 2003

References:

1. Birkhoff G &G.C. Rota – Ordinary Differential Equations – Wiley
2. E.A. Coddington – An introduction to Ordinary Differential Equations – Prentice Hall India
3. Chakrabarti – Elements of Ordinary Duifferential Equations & Special Functions – Wiley Eastern

MS**MAT03O06 BASIC REAL ANALYSIS**

Course objective: The aim of this course is to develop basic concepts like limit, convergence, differentiation and Riemann integral. Convergence of functions and the Stone-Weierstrass theorem are also discussed in detail.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of real analysis – sequence, series, differentiable functions and integrable functions.

Unit 1

Basic Topology-Finite,Countable and uncountable Sets Metric spaces, Compact Sets ,Perfect Sets, Connected Sets.

Continuity-Limits of function, Continuous functions, Continuity and compactness, continuity and connectedness, Discontinuities, Monotonic functions, Infinite limits and Limits at infinity.

Unit 2

Differentiation, Derivative of a real function. Mean value theorems, Continuity of derivatives. L Hospital's rule. Derivatives of higher order. Taylor's theorem. Differentiation of vector valued functions

Unit 3

Reimann – Stieltjes integral. Definition and existence of the integral. Integration and differentiation. Integration of vector – valued functions. Rectifiable curves.

Unit 4

Sequences and series of functions. Uniform convergence. Uniform convergence and continuity. Uniform convergence and differentiation.
Equicontinuous families of functions. Stone – Weierstrass theorem
.

Text: Walter Rudin – Principles of Mathematical Analysis (3rd edition) – Mc Graw Hill, Chapters2,4, 5,6, and 7(up to and including 7.27 only)

References:

1. T.M. Apostol – Mathematical Analysis (2nd edition) – Narosa
2. B.G. Bartle – The Elements of Real Analysis – Wiley International
3. G.F. Simmons – Introduction to Topology and Modern Analysis – McGraw Hill

4. : Pugh, Charles Chapman: Real Mathematical Analysis, springer ,2015.

5. Sudhir R. Ghorpade , Balmohan V. Limaye , A Course in Calculus and Real Analysis

(Undergraduate Texts in Mathematics) , springer, 2006

MS**MAT03O07** **BASIC TOPOLOGY**

Course Objective: To present an introduction to the theory of topology, a powerful tool for understanding other branches of mathematics based on advanced mathematics.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of topology- topological spaces, continuous functions, connected sets and compact sets.

Unit 1

Topological spaces, Basis for a topology, The order topology, The product toplogy(finite), The subspace topology, Closed sets and limit points, (sections 12 to 17)

Unit 2

Continuous functions, The product topology, The metric topology, The metric topology (continued), The quotient topology , Connected spaces, Connected subspace of the real line, (sections 18 to 24)

Unit 3

Compact spaces, compact subset of the real line, The countability axioms, The separation axioms, (section 26, 27, 30, 31)

Unit 4

Normal spaces, The Urysohn lemma, The Urysohn metrisation Theorem, Tietze extension Theorem, The Tychonoff theorem. (sections 32 to 35, 37)

Text: J.R. Munkres – Topology, Pearson India, 2015.

References:

1. K.D. Joshi – Introduction to General Topology, New age International (1983)
2. G.F. Simmons – Introduction to Topology & Modern Analysis – McGraw Hill
3. M. Singer and J.A. Thorpe – Lecture Notes on Elementary Topology and Geometry, Springer Verlag 1967
4. Kelley J.L. – General Topology, von Nostrand
5. Stephen Willard – General Topology, Dover Books in Mathematics.

MSMAT03O08 **APPLIED FUZZY MATHEMATICS**

Course Objective: The aim is to provide an introduction to the fundamental concepts of Fuzzy Mathematics.

Course Learning outcome: After successful completion of the course, student will be able to understand the basics of fuzzy mathematics.

Unit 1

From classical (crisp) sets to fuzzy sets: characteristics and significance of the paradigm shift. Additional properties of α-cuts. Representation of fuzzy sets. Extension principle for fuzzy sets. (Chs. 1 & 2 of the Text Book)

Unit 2

Operations on fuzzy sets. Types of operations. Fuzzy complements. t-norms, t-conorms.

Combinations of operations. Aggregate operations. , Fuzzy numbers Arithmetic operations on intervals. Arithmetic operations on fuzzy numbers. Lattice of fuzzy numbers (Sections 3.1 to 3.4 of Ch. 3 of the Text and sections 4.1 to 4.5)

Unit 3

Crisp and fuzzy relations, projections and cylindric extensions, binary fuzzy relations, binary relations on a single set, Fuzzy equivalence relations , Compatibility and ordering relations. (sections 5.1 to5.6 of chapter 5 of text 5)

Unit 4

Fuzzy morphisms. sup-i, inf- ωicompositions of fuzzy relations. Fuzzy logic. Fuzzy propositions. Fuzzy quantifiers. Linguistic hedges. Inference from conditional, conditional and qualified and quantified propositions (Sections 5.8 to 5.10 of Ch. 5 of the Text, and Ch. 8 of the Text)

Text Book: Fuzzy sets and Fuzzy logic Theory and Applications – G. J. Klir & Bo Yuan – PHI (1995)

References :

1. Zimmermann H. J. – Fuzzy Set Theory and its Applications, Kluwer (1985)
2. Zimmermann H. J. – Fuzzy Sets, Decision Making and Expert Systems, Kluwer (1987)
3. Dubois D. & H. Prade – Fuzzy Sets and Systems: Theory and Applications – Academic Press (1980)

Model Question
Kannur University
MSMAT01C05 Topology(Mathematics)

Part A
Answer any five questions, each question carries 3 marks.

1. Define the topology τ generated by a basis and explain the concept with an example.
2. Define product topology and give an example.
3. Explain metric topology with an example.
4. Define quotient topology and give an example.
5. Define first countable space and give an example.
6. State
   1. Tychnoff Theorem and
   2. Tietze extension Theorem.

Part B
Answer any three questions, each question carries 5 marks.

7. Show that X is Hausdorif if and only if the diagonal $\Delta = \{(x, x) : x \in X\}$ is closed in $X \times X$.
8. Show that the countable collection $((a, b) \times (c, d), a < b$ and $c < d$, and a, b, c, d are rational) is a basis for $\mathbb{R}^2$.
9. Show that the subspace (a, b) of $\mathbb{R}$ is homeomorphic with $(0, 1)$ and the subspace $[a, b]$ of $\mathbb{R}$ is homeomorphic with $[0, 1]$.
10. Show that every metrizable space is normal.
11. Show that in the finite complement topology on IR, every subspace is compact.

Part C
Answer any three questions, each question carries 10 marks.

12. (a) Let X be a topological space. Then show that the following conditions hold:
    (1) 0 and X are closed.
    (2) Arbitrary intersections of closed sets are closed.
    (3) Finite unions of closed sets are closed.

(b) Let A be a subset of the topological space X. (a) Then show that $x \in \overline{A}$ if and only if every open set U containing x intersects A. (b) Supposing the topology of X is given by a basis, then also show that $x \in A$ if and only if every basis element B containing x intersects A.

13. (a) Show that the topologies on $\mathbb{R}^n$ induced by the euclidean metric d and the square metric ρ are the same as the product topology on $\mathbb{R}^n$.

    (b) Show that the uniform topology on $\mathbb{R}^J$ is finer than the product topology and coarser than the box topology; these three topologies are all different if J is infinite.

14. (a) Show that the union of a collection of connected subspaces of X that have a point in common is connected.

    (b) Show that a finite cartesian product of connected spaces is connected.

15. (a) Show that every compact subspace of a Hausdorff space is closed.

    (b) Let X be a simply ordered set having the least upper bound property. Show that in the order topology, each closed interval in X is compact.

16. (a) Show that very regular space with a countable basis is normal.

    (b) Show that every well-ordered set X is normal in the order topology.