KANNUR UNIVERSITY

(Abstract)

New Generation Course in affiliated Colleges- M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme --- under Credit Based Semester System -Scheme, Syllabus and model question papers of core and generic elective courses with modified Course Code- implemented w.e.f 2020-21 admission --- Orders issued

ACADEMIC C SECTION

Acad/C2/16583/NGC/2021 Dated: 12.11.2021

Read:-1. U.O No Acad/C2/16583/NGC/2021 dated 23.01.2021
2. U.O Note No. EX/EG-1-1/21498/PG/Oct2020 dated 14.09.2021
3. Letter No, Acad C2/2408/2020 dated 24.09.2021
4. The Minutes of the meeting of Board of Studies in Mathematics (PG) held on 05.10.2021

ORDER

1. As per the paper read (1) above, the Scheme, Syllabus and pattern of question papers of the Core & Generic Elective Course of M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme under CBSS (New Generation programme) was implemented w.e f 2020-21 admission.
2. Meanwhile, the Examination Branch, as per paper read (2) above, pointed out the practical difficulty in conducting Examinations for the new generation programme M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management), as its Course Code is the same as that of the conventional PG programme, M.Sc. Mathematics.
3. Subsequently, the Board of Studies in Mathematics (PG) was entrusted to modify the Course Codes of M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme, as per the paper read (3) above.
4. Accordingly, the Meeting of the Board of Studies in Mathematics (PG), resolved to modify the Course Code of M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme by replacing the prefix 'MAT' with 'MAF'. As per paper read (4) the Chairperson of Board of Studies Mathematics (PG) submitted the Scheme, Syllabus and pattern of Question papers of the Core Courses and Generic Elective Courses of M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme, after effecting the modification of the Courses Codes.
5. The Vice Chancellor, after considering the matter in detail and in exercise of the powers of Academic Council conferred under Section 11(1) Chapter III of Kannur University Act 1996, accorded sanction to implement the modified Scheme, Syllabus and pattern of Question papers of the Core Courses and Generic Elective Courses of M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme (CBSS) offered at Sree Narayana College,Thottada, Kannur, with effect from 2020-21 admission, subject to reporting to the Academic Council.
6. The modified Scheme, Syllabus and Model Question Papers of the Core Course and Generic Elective Course of the M.Sc. Mathematics (Multivariate Calculus & Mathematical Analysis Modeling & Simulation, Financial Risk Management) programme (CBSS) applicable w.e.f 2020-21 admission are uploaded in the University website (www.kannuruniversity.ac.in).
7. The U. O read (1) above stands modified to this extent.

Orders are issued accordingly.

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

Sd/-
BALACHANDRAN V K
DEPUTY REGISTRAR (ACAD)
For REGISTRAR

To: The Principal
Sree Narayana College, Thottda, Kannur

Copy To: 1. The Examination Branch (through PA to CE)
2. PS to VC/PA to PVC/PA to Registrar
3. DR/ARI Academic
4. The Web Manager (for uploading in the website)
5. SF/DF/FC

Forwarded / By Order
SECTION OFFICER

KANNUR UNIVERSITY

M.Sc MATHEMATICS

**(Multivariate Calculus and Mathematical Analysis,
Modelling & Simulation, Financial Risk Management)**

under

KUCBSS

Scheme and Syllabus
2020-21

Introduction

Education is a platform in which our new generations are trained and make them ready for future . Education provides knowledge and skills which help the person to be employable.

Mathematics is the study of quantity, structure, space and change and it has been regarded as a fundamental subject because arithmetic and logical reasoning are the basis of science and technology. Mathematician seeks out patterns and formulate new conjectures which resolve the truth and falsity of conjectures by mathematical proofs.

To cope up with the new developments in the field of mathematics we are in need of new generation courses. With this in mind we prepared a new syllabus and curriculum for the new generation course MSc Mathematics which will meet our requirements.

This programme has the following broad objectives:

1. To emphasize the relevance and usefulness of mathematics from an application point of view;

2. To equip the learners with the core mathematical knowledge and training necessary for use in many application areas;

3. To expose the learner to real-life problems and promote the use of mathematics in industry and applied sciences;

4. To develop human resource in emerging disciplines such as Mathematical Modeling, Computational Mathematics, risk management etc.

Programme Outcomes

At the end of the programme the student will be able to

1. Apply the knowledge of mathematical concepts in interdisciplinary fields.
2. Understand the nature of abstract mathematics and explore the concepts in further details.
3. Model the real world problems and find appropriate solutions.
4. Pursue research in challenging areas of pure and applied mathematics.
5. Continue to acquire mathematical knowledge and skills to develop professional activities.
6. Effectively communicate and explore ideas of mathematics for propagation of knowledge and popularization of mathematics in society.

Eligibility

1. Eligibility for admission will be as per the rules laid down by the University from time to time. The course shall be offered in four semesters within a period of two academic years. The applicant must be holder of a Bachelor's Degree in Mathematics or Bachelor's Degree (Honours) in Mathematics.

SCHEME AND SYLLABUS

M.Sc MATHEMATICS

(Multivariate Calculus and Mathematical Analysis, Modelling & Simulation, Financial Risk Management)

COURSE STRUCTURE

Course Code	Course Title	Lecture Hours/Week	Duration of Examination (Hours)	Credits	Marks

FIRST SEMESTER

MAF1C01	Basic Abstract Algebra	5	3	4	100
MAF1C02	Linear Algebra	5	3	4	100
MAF1C03	Mathematical Analysis	5	3	4	100
MAF1C04	Basic Topology	5	3	4	100
MAF1C05	Differential Equations	5	3	4	100
			Total	20	500

SECOND SEMESTER

MAF2C06	Advanced Abstract Algebra	5	3	4	100
MAF2C 07	Measure and Integration	5	3	4	100
MAF2C08	Advanced Topology	5	3	4	100
MAF2C09	Foundations of Complex Analysis	5	3	4	100
MAF2C10	Partial Differential Equations& integral equations	5	3	4	100
			Total	20	500

THIRD SEMESTER

MAF3C11	Number Theory	5	3	4	100
MAF3C12	Functional Analysis	5	3	4	100
MAF3C13	Complex Function Theory	5	3	4	100
MAF3C14	Multivariate Calculus	5	3	4	100
MAF3E01/02/03	Elective-1	5	3	4	100
			Total	20	500

FOURTH SEMESTER

MAF4C15	Financial Risk Management	5	3	4	100
MAF4C16	Modelling & Simulation	5	3	4	100
MAF4E01/02/03	Elective-2	5	3	4	100
MAF4Pr01	Project Work	10	-	4	100
MAF4V01	Viva-Voce	-	-	4	100
			Total	20	500

Total Marks: 2000

Total Credits: 80

The students may choose one elective from each of the following.

Elective 1

1. MAF3E01 Graph Theory
2. MAF3E02 Probability Theory
3. MAF3E03 Calculus of Variations

Elective 2

1. MAF4E01 Operator Theory
2. MAF4E02 Differential Geometry
3. MAF4E03 Operations Research

CONTINUOUS ASSESSMENT (CA)

This assessment shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory course and based on tests, lab skill, records/viva and attendance in respect of practical course.

The percentage of marks assigned to various components for internal evaluation is as follows.

THEORY

	Components	% of internal marks
i	Two test papers	40
ii	Assignments and Viva	20
iii	Seminars/Presentation of course study	20
iv	Attendance	20

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of external examination. There shall not be any chance for improvement for internal marks.

The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the college Principle, after endorsed by the HoD,

TESTS

For each course there shall be at least two class tests during a semester. The probable dates of the tests shall be announced at the beginning of each semester. Marks should be displayed on the notice board. Valued answer scripts shall be made available to the students for perusal within 10 working days form the date of the tests.

ASSIGNMENTS

Each student shall be required to do 2 assignments for each course. Assignments after valuation must be returned to the students.

SEMINAR

Each student shall deliver one seminar as an internal component for every course and must be evaluated by the respective teacher in terms of structure,

QUESTION PAPER PATTERN

Each question paper in all semesters will have Two Parts, Part A and Part B, Part A will have six short answer questions out of which four are to be answered. The questions are to be evenly distributed over the entire syllabus. Each question carries 4 marks. Part B will have three units, each unit consists of three questions from the respective three units of the syllabus. Four questions are to be answered form B without omitting any unit. Each question carries 16 marks.

Project Work:

The project report shall be prepared according to the guidelines approved by the university. Two typed copies of the project report shall be submitted to the Head of the Department, two weeks before the commencement of the ESE of the final semester. The topic of the project work must be chosen from any area in Mathematics, which is a not already covered in the syllabus prescribed for the new generation MSc Programme of Kannur University. Every student has to do the project work independently. No group projects are accepted. The project should be unique with respect to title, project content and Project layout. No two project reports of any student should be identical, in any case, as this may lead to the cancellation of the project report by the university.

The project work has to be evaluated by two external examiners, followings the guidelines given below:

Components of Evaluation of Project Work:

	Components	**Weightage**
a	Content	1
b	Methodology	1
c	Presentation	2
d	Viva-Voce	1

Project:-

i) ***Arrangement of contents***

The project should be arranged as follows-

1. Cover page and title page
2. Bonafide certificate/s
3. Declaration by the student
4. Acknowledgment
5. Table of contents
6. List of tables
7. List of figures
8. List of symbols, Abbreviations and Nomenclature
9. Chapters
10. Appendices
11. References:

ii) ***Page dimension and typing instruction***

The dimension of the Project report should be in A4 size. The project report should be printed in bond paper and bound using flexible cover of the thick white art paper or spiral binding. The general text of the report should be typed with 1.5 line spacing. Paragraph should be arranged in justified alignment with margin 1.25" each on top, left and right of the page with portrait orientation. The content of the report shall be around 40pages.

iii) ***<u>A typical specimen of Bonafide Certificate</u>***

KANNUR UNIVERSITY

<Font style Times New Roman-size 18>

BONAFIDE CERTIFICATE

<Font style Times New Roman-Size 16>

<Font Style Times New Roman-size 14>

Certificate that this project report "………………TITLE OFTHEPROJECT .... " isthe bonafide work of "……………………NAME OF THE CANDIDATE…………" who carried out the project work under mysupervision.

<<signatureofHoD>>	<<signature ofSupervisor/Co-supervisor>>
SIGNATURE	SIGNATURE
<<Name>>	<<Name>>
HEAD FOTHEDEPARTMENT	SUPERVISOR
<<AcademicDesignation>>	<<AcademicDesignation>>
<<Department>>	<<Department>>
<<Seal with full address of theDept.&college>>	<<Seal with fulladdress>>

iv) ***<u>Declaration by the student</u>***

DECLARATION

I,……………………….., hereby declare that the Project work entitled……………..(Title of the Project), …………………………………………………has been prepared by me and submitted to Kannur University in partial fulfillment of requirement for the award of Master of Science of in …………….. with specialization in ……………………….is a record of original work done by me under the supervision of Dr./Prof………………..of Department of ....college/(Name of Institute).

I also declare that this Project work has not been submitted by me fully or partly for the award of any Degree, Diploma, Title or recognition before any authority.

Place

Date Signature of the student

(Reg. No)

ATTENDANCE

The students admitted in the P.G programme shall be required to attend at least 75% percent of the total number of classes (theory/practical) held during each semester. The students having less than prescribed percentage of attendance shall not be allowed to appear for the University examination.

Condonation of shortage of attendance to a maximum of 10% of the working days in a semester subject to maximum of two times during the whole period of post graduate programme may be granted by the Vice-Chancellor of the University. Benefit of condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meeting of the University bodies and participation in other extracurricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for such condonation shall repeat the course along with the subsequent batch.

Student who complete the course and secure the minimum required attendance for all the course of a semester and register for the University examinations at the end of the semester alone will be promoted to higher semester.

The students who have attendance within the limit prescribed, but could not register for the examination have to apply for the ***token registration***, within two weeks of the commencement of the next semester.

Attendance of each course will be evaluated (internally) as below:-

Attendance	**% of marks for attendance**
Above 90% attendance	100
85 to <90%	80
80 to <85%	60
76 to <80%	40
75%	20
<75	Nil

EVALUATION AND GRADING

The evaluation scheme for each course (including projects) shall contain two parts; (a) Continuous Assessment (CA) and (b) End Semester Evaluation (ESE). **20%** marks shall be given to CA and the remaining **80%** to ESE. The ratio of marks between **internal and external is 1:4.** Both internal and external evaluation shall be carried out using marks with corresponding grades and grade points in **7-point indirect relative grading system**.

COMPREHENSIVE VIVA-VOCE

A comprehensive viva-voce at the end of IV semester shall be conducted for each student to assess the overall mathematical ideas assimilated by the student during their post graduate programme. A team comprising of two teachers shall be appointed for conducting the viva- voce. The modus operandi of conducting viva-voce shall be decided by convening a meeting of Board of Examiners from time to time.

MAF1C01 BASIC ABSTRACT ALGEBRA

Text Book: John. B. Fraleigh – A First Course in Abstract Algebra (7th Edition)**,** Narosa (2003)

Unit I

Direct Products and finitely generated Abelian Groups, Group Action on a Set, Applications of Sylow Theorems.
(Chapter-2: Section 11; Chapter-3: Section 16; Chapter-7: Sections 36, 37)

Unit II

Field of Quotients of the Integral Domain, Isomorphism Theorems, Series of Groups, Free Abelian Groups, Field of Quotients of the Integral Domain
(Chapter-4: Section 21, Chapter-7: Section 34, 35, 38).

Unit III

Ring of Polynomials, Factorization of Polynomials over a Field, Homomorphisms and Factor Rings, Prime and Maximal Ideals
(Chapter-4: Section 22, 23; Chapter-5: Section 26, 27).

Reference:

1. I.N. Herstein: Topics in Algebra.Wiley India Pvt. Ltd,2006
2. D.S.Malik,John.N. Merdson,M.K. Sen:Fundamentals of Abstract Algebra Mc Graw-hill Publishing Co.,1996
3. Clark, Allen: Elements of Abstract Algebra. Dover Publications,1984
4. David M. Burton: A First course in Rings and Ideals.Addison-Wesley Educational Publishers Inc.,1970
5. Joseph. A. Gallian: Contemporary Abstract Algebra. Narosa,1999
6. M. Artin: Algebra Addison Wesley; 2nd edition,2010

MAF1C02 LINEAR ALGEBRA

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

Unit I

Linear Transformations: Liner Transformations, The Algebra of Linear Transformations, Isomorphism, Representation of Transformation by Matrices, Linear Functional, The Double Dual The Transpose of a Linear Transformation.

(Chapter-3; Sections 3.1, 3.2,3.3, 3.4, 3.5, 3.6, 3.7)

Unit II

Elementary Canonical Forms: Introductions, Characteristic Values, Annihilating Polynomials Invariant Subspace, Simultaneous Triangulations & Simultaneous Diagonalisation.

(Chapter-6: Section 6.1, 6.2,6.3, 6.4, 6.5, 6.6)

Unit III

Elementary Canonical Forms: Invariant Direct Sums, The Primary Decomposition Theorem.

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

Inner Product Spaces: Inner Products, Inner Product Spaces.
(Chapter-6: Sections 6.7, 6.8; Chapter-7: Sections: 7.1, 7.2, 7.3 (Omit Proof of the theorems in this (7.3) section); Chapter-8: Sections 8.1, 8.2)

Reference:

1. Stephen H. Friedberg, Arnold J Inseland Lawrence E.Spence: Linear Algebra: 4th Edition 2002: Prentice Hall.
2. Serge A Land: Linear Algebra; Springer
3. Paul R Halmos Finite-Dimensional Vector Space; Springer 1974.
4. McLane & Garrell Birkhoff; Algebra; American Mathematical Society 1999.
5. Thomas W. Hungerford: Algebra; Springer1980
6. Neal H. McCoy & Thomas R.Berger: Algebra-Groups, Rings & Other Topics: Allyn &Bacon.
7. S Kumaresan; Linear Algebra A Geometric Approach; Prentice-Hall of India 2003.

MAF1C03 MATHEMATICAL ANALYSIS

Text Book I: Walter Rudin: Principles of Mathematical Analysis; 3rd Edition McGraw-Hill International

Text Book 2: T.M Apostol: Mathematical Analysis 2nd Edition; Narosa Publications (1973)

Unit-I

Basic Topology: Finite, Countable and Uncountable Sets, Metric Spaces, Compact Sets Perfect Sets, Connected Sets, Continuity: Limits of Functions, Continuous Functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic Functions, Infinite limits and Limits at Infinity.

(Text Book1; Chapter-2, All sections: Chapter-4, All sections)

Unit-II

Differentiation: The derivative of Real Function, Mean Value Theorems, The Continuity of Derivatives, L 'Hospital' s Rule, Derivatives of Higher Order Taylor's Theorem, Differentiation of Vector-Valued Functions. The Riemann-Stieltjes Integral: Definition and Existence of the Integral, Properties of the Integral.

(Text Book 1: Chapter-5; All sections; Chapter-6; sections 6.1 to 6.19)

Unit-III

The Riemann-Stieltjes Integral (Continued); Integration and Differentiation, Integration of Vector-Valued Functions,

(Text Book 1: Chapter-6; Sections 6.20 to 6.25;)

Functions of Bounded Variations and Rectifiable Curves.

(Text Book2; Chapter-6; Sections 6.1 to 6.12)

Reference:

1. R.G Bartle and D.R Sherbert; Introduction to Real Analysis; John Wiley Bros.1982
2. L.M Graves; The Theory of functions of real variable; Tata McGraw-Hill BookCo.
3. M.H Porter and C.B Moraray;A first Course in Real Analysis; Springer Verlag UTM1977.
4. S.C Sexena and S.M Shah: Introduction to Real Variable Theory, Intext Educational Publishers, SanFrancisco
5. S.R Ghopade and B.V Limaye; A Course in Calculus and Real Analysis, Springer.
6. N.L Carothers-Real Analysis Cambridge UniversityPress.

MAF1C04 BASIC TOPOLOGY

Text: C. Wayne Patty, Foundations of Topology, Second Edition – Jones & Bartlett India Pvt. Ltd., New Delhi,2012.

Unit – I

Topological Spaces: The Definition and Examples, Basis for a Topology, Closed Sets, Closures and Interiors of Sets, Metric spaces, Convergence, Continuous functions and Homeomorphisms.

[Chapter 1: Sections 1.2 to 1.7, excluding Theorem 1.46 and Theorem 1.51]

Unit – II

New spaces from old ones: Subspaces, The Product Topology on X x Y, The Product Topology, The Weak Topology and the Product Topology.

[Chapter 2: Sections 2.1 to 2.4]

Unit – III

Connectedness in metric spaces: Connected spaces, Pathwise and Local connectedness, Totally disconnected space,

[Chapter 3: Sections 3.1 to 3.3 excluding Theorem 3. 29 and Theorem 3.30]

References:

1. K. D. Joshi, *Introduction to General Topology*, New Age International (P) Ltd., Publishers.
2. Dugundji, *Topology*, Prentice Hall of India.
3. G. F. Simmons, *Introduction to Topology and Modern Analysis*, Mc Graw Hill.
4. S. Willard, *General Topology* , Addison Wesley Publishing Company.
5. J. R. Munkres, *Topology: A First Course*, Prentice Hall of India.
6. Murdeshwar M. G., *General Topology*, second edition, Wiley Eastern.
7. Kelley, *General Topology*, van Nostrand, Eastern Economy Edition.

MAF1C05 DIFFERENTIAL EQUATIONS

Text Book: G.F Simmons - Differential Equations with Historical Notes; Third Edition-CRC Press, Taylor and Francis Group.

Unit I

Introduction: A Review of Power Series, Series Solutions of First Order Equations, Second Order Linear Equations. Ordinary Points , Regular Singular Points, Regular Singular Points (Continued), Gauss's Hyper Geometric Equation, The Point at Infinity.

(Chapter-5; Sections 26 to 32)

Unit II

Legendre Polynomials, Properties of Legendre Polynomials, Bessel Functions. The Gamma Function, Properties of Bessel functions, General Remarks on Systems, Linear Systems Homogeneous Linear Systems with Constant Coefficients.

(Chapter-8;Sections 44 to 47; Chapter-10;Sections 54 to 56)

Unit III

Oscillations and the Sturm Separation Theorem, The Sturm Comparison Theorem, The Method of Successive Approximations, Picard's Theorem, Systems. The Second Order Linear Equation (Chapter-4;Sections 24and25;Chapter-13;Sections 68to70)

References

1. G.Birkoff and G.C Rota: Ordinary Differential Equations; Wileyand Sons; 3rd Edition(1978)
2. E.A Coddington; An Introduction to Ordinary Differential Equations; Prentice Hall of India, New Delhi(1974)
3. P.Hartmon; Ordinary Differential Equations; John Wiley and Sons
4. Chakraborti; Elements of Ordinary Differential Equations and Special Functions; Wiley Eastern Ltd New Delhi(1990)
5. L.S Poutrigardian: A Course in Ordinary Differential Equations; Hindustan Publishing Corporation Delhi(1967)
6. S.G Deo &V.Raghavendra; Ordinary Differential Equations and Stability Theory; Tata McGraw Hill New Delhi(1967)
7. V.I Arnold; Ordinary Differential Equations; MIT Press, Cambridge1981.

MAF2C06 ADVANCED ABSTRACT ALGEBRA

Text Book: John.B.Fraleigh, A First Course in Abstract Algebra (7th Edition), Narosa (2003)

Unit I

Unique Factorization Domains, Euclidean Domains, Gaussian Integers and Multiplicative Norms, Introduction to Extension Fields (Chapter-9: Section - 45, 46, 47 and Chapter-6: Section - 29).

Unit II

Algebraic Extensions, Geometric Constructions, Finite Fields, Automorphisms of Fields. (Chapter-6: Section - 31, 32, 33 and Chapter-10 : Section- 48).

Unit III

The Isomorphism Extension Theorem, Splitting Fields, Separable Extensions. Galois Theory (Chapter-10: Section – 49, 50, 51, 53).

References:

1. I. N. Herstein: Topics in Algebra. Wiley India Pvt. Ltd,2006
2. D. S. Malik, John. N. Merdson, M. K. Sen: Fundamentals of Abstract Algebra Mc Graw-hill Publishing Co.,1996
3. Clark, Allen: Elements of Abstract Algebra. Dover Publications,1984
4. David M. Burton: A First course in Rings and Ideals. Addison-Wesley Educational Publishers Inc.,1970
5. Joseph. A. Gallian: Contemporary Abstract Algebra. Narosa,1999

M. Artin: Algebra Addison Wesley; 2nd edition, 2010

MAF2C07 MEASURE AND INTEGRATION

Text Book; G de Barra, Measure Theory and Integration. New age International Publishers, New Delhi (First Edition, 1981)

Unit I

Measure on the real line; Lebesgue Outer measure, Measurable sets, Regularity, Measurable Functions, Borel and Lebesgue Measurability (Including Theorem 17),
Integration of functions of a Real Variable; Integration of Non-negative Functions.

(Chapter-2; Section 2.1-2.5, Chapter-3-Section 3.1)

Unit II

Integration of functions of a Real Variable; The general Integral, Riemann and Lebesgue Integrals
Abstract Measure Space; Measures and Outer measures, extension of measure, Uniqueness of the extension.

(Chapter-3, Section 3.2 and 3.4; Chapter-5; Section 5.1 –5.3)

Unit III

Abstract Measure Spaces; Measure Spaces, Integration with respect to a Measure
Inequalities and the L^P Spaces; The L^P Spaces, The inequalities of Holder and Minkowski, Completeness of L^P (X)

(Chapter-5, Section 5.5 –5.6; Chapter-6-section 6.1, 6.4 and 6.5)

Reference:
1. Walter Rudin; Real and Complex Analysis; 3rd Edition, Tata McGraw Hill
2. P.R Halmos; Measure Theory; D.Van Nostrand Co.
3. A.E Taylor; General Theory of Functions and Integrations; Blaisadel Publishing Company, New York
4. Inderk Rana; An Introduction to Measure and Integration; Narosa Publishing House, New Delhi.1997.
5. Royden H.L Real Analysis Macmillan &Co
6. N.L Carothers-Real Analysis Cambridge Press.

MAF2C08 ADVANCED TOPOLOGY

Text:

C. Wayne Patty, Foundations of Topology, Second Edition – Jones & Bartlett India Pvt. Ltd., New Delhi,2012.

Unit–1

Compactness: Compactness in metric spaces, Compact spaces. Local compactness and the relation between various forms ofcompactness.

[Chapter 4: Sections 4.1 to 4.3 excluding Corollary 4.22]

Unit – Il

The Separation and Countability Axioms: T_0, T_1 & T_2 spaces, Regular and completely regular spaces, Normal and completely normal spaces, The countability axioms.

[Chapter 5: Sections 5.1 to 5.4 excluding Examples 3, 5 and 6 and Theorem 5.10. Also exclude the proof that the Moore Plane is Completely Regular.]

Unit – III

Urysohn's Lemma and Tietze Extension Theorem, Special Topics: Urysohn's Lemma and Tietze Extension Theorem, The Alexander Subbase and Tychonoff Theorems, Urysohn's Metrization Theorem, Homotopy of Paths.

[Chapter 5: Section 5.5, Chapter 6: Section 6.7 excluding Example 20; Chapter 7: Section 7.1;

Chapter 8: Section 8.1]

References:

1. K. D. Joshi, *Introduction to General Topology*, New Age International (P) Ltd., Publishers.
2. Dugundji, *Topology*, Prentice Hall of India.
3. G. F. Simmons, *Introduction to Topology and Modern Analysis*, Mc GrawHill.
4. S. Willard, *General Topology* , Addison Wesley Publishing Company.
5. J. R. Munkres, *Topology: A First Course,* Prentice Hall of India.
6. Murdeshwar M. G., *General Topology*, second edition, Wiley Eastern.
7. Kelley, *General Topology,* van Nostrand, Eastern Economy Edition.

MAF2C09 FOUNDATIONS OF COMPLEX ANALYSIS

Text Book: John B Conway- Functions of One Complex Variable, 2^{nd} Edition, Springer International StudentEdition.

Unit I Analytical Functions, Complex Integration

Power Series representation of Analytic Functions, Zeroes of an analytic function, The index of a closed curve, Cauchy's Theorem and Integral Formula, The homotopic version of Cauchy's Theorem and simple connectivity, Counting zeros the Open Mapping Theorem, Goursat's Theorem

Chapter IV Sections 2 to 8 . (2.1 to 3.6 proof omitted)

Unit II

Singularities

Classification of singularities, Residues, The Argument Principle

The Maximum Modulus Theorem

The Maximum Principle, Schwarz's Lemma

Chapter V Sections 1 to 3 , Chapter VI Sections 1 and 2

Unit III

Compactness and Convergence in the Space of Analytic Functions

The Spaces of continuous functions C(G, Ω), Spaces of analytic functions, The Riemann Mapping Theorem, Weierstrass Factorization Theorem.

Chapter VII Section 1 to 2; and 4 to 5

Reference :

1. Louis Pennise: Elements of Complex Variable Half, Richart &Winston 1976
2. Silverman.H:Complex Variable, Haughton Miffin Complex,Boston 1975.
3. Rudin.W:Realand Complex Analysis(3^{rd}Edition) McGrawHill International Edition1967.
4. E.TCopson: An Introduction to the Theory of a Complex Variables, Oxford University Press1974.
5. Lars V.Ahlfors – Complex Analysis (3^{rd}Edition), McGraw-Hall international edition

MAF2C10 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL EQUATIONS

Text Book: 1.Amarnath M: Partial Differential Equations, Narosa, New Delhi(1997) 2.HildebranF.B: Methods of Applied Mathematics,(2nd Edition) Prentice- Hall of India,NewDelhi(1972)

UNIT I

First Order P.D.E.

Curves and Surfaces, Genesis of first order Partial Differential Equations, Classification of integrals, Linear equations of first order, Pfaffian differential equations, Compatible systems, Charpit's method, Jacobi's method, Integral surfaces passing through a given curve, Quasi linearequations.

[Sections 1.1 – 1.10. from the Text 1]

UNIT II

Second Order P.D.E.

Genesis of second order Partial Differential Equations. Classification of second order Partial Differential Equations. One dimensional Wave Equation:

Vibrations of an infinite String , Vibrations of semi-infinite String, Vibrations of a String of Finite Length, Riemann's Method, Vibrations of a String of Finite Length (Method of Separation of Variables).

Laplace's Equation:

Boundary Value Problems, Maximum and Minimum Principles, The Cauchy Problem, The Dirchlet Problem for the Upper Half Plane, The Neumann Problem for the Upper Half Plane.

Heat Conduction Problem:

Heat Conduction - Infinite Rod Case, Heat Conduction – Finite Rod Case.

Duhamel's Principle:

Wave Equation, Heat Conduction Equation.

[Sections 2.1 – 2.6. from the Text 1. Omit sections 2.4.6 to 2.4.13]

UNIT III

Integral Equations.

Introduction ,Relation Between differential and Integral Equation, The Green's Function, Frdholm Equation With Separable Kernels, Illustrative Examples, Hilbert Schmidt Theory, Iterative Methods for Solving Equations of the Second Kind.

[Sections 3.1 – 3.3, 3.6 – 3.9 from the Text 2]

REFERENCES

1. E.A. Coddington : An Introduction to Ordinary Differential Equations
Printice Hall of India ,New Delhi (1974)

2. F. John : Partial Differential Equations Narosa Pub. House New Delhi(1986)
3. Phoolan Prasad & : Partial Differential Equations Renuka Ravindran Wiley Eastern Ltd New Delhi(1985)
4. R. Courant and D. Hilbert : Methods of Mathematical Physics , Vol I Wiley Eastern Reprint(1975)
5. W.E. Boyce & R.C. Deprima : Elementary Differential Equations and Boundary Value Problems
John Wiley & Sons, NY, 9th Edition
6. Ian Sneddon : Elements of Partial Differential Equations
McGraw-Hill International Edn., (1957)

MAF3C11 NUMBER THEORY

Text Book:

1. Tom M Apostol: Introduction to Analytic Number Theory; Springer International Student Edition
2. D.M Burton: Elementary Number Theory (6thEdition) McGraw Hill
3. Lan Stewart and David Tall: Algebraic Number Theory and Fermat's last theorem (Third Edition) A K Peters Natick Massachussets

Unit I

The Fundamental theorem of Arithmetic: Introduction-Divisibility-Greatest common divisor-prime numbers- The fundamental theorem of arithmetic-The series of reciprocals of primes-The Euclidean algorithm-The greatest common divisor of more than two numbers.
(Text 1, Sectons1.1-1.8)

Arithmetical Functions and Dirichlet multiplication: Introduction- The Mobius function–$\mu(n)$ The Euler totient function $\varphi(n)$ –The relation connecting The Mobius function μ and The Euler totient function φ -the product formula for $\varphi(n)$ –The Dirichlet product of arithmetical functions- Dirichlet inverses and Mobius inversion formula- The Mangolt function $\Lambda(n)$ –Multiplicative functions-Multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function- Liouville's function $\lambda(n)$- The divisor function $\sigma_\alpha(n)$.

(Text 1, Section 2.1-2.13)

Congruences: Definition and basic properties of congruences- Residue classes and complete residue system- Liner Congruences-Reduced residue system and the Euler- Fermat theorem-Polynomial congruences modulo p and Langrange's theorem- Applications of Langrange's theorem- Simultaneous linear congruences and Chinese Remainder theorem- Applications of Chinese remainder theorem- Polynomial congruences with prime power moduli.

(Text 1, Section 5.1-5.9)

Unit II

Quadratic Residues and Quadratic Reciprocity Law: Quadratic residues- Legendre's symbol and its properties- Evaluation of $(-1|p)$ and $(2 \mid p)$ Gauss lemma-The quadratic reciprocity law –Applications of the reciprocity law – The Jacobi symbol- Applications to Diophantine equations.

(Text 1, Sections 9.1 –9.8)

Primitive Roots: The exponent of number mod m and primitive roots- Primitive roots and reduced residue; system- The nonexistence of primitive roots mod 2a for $\alpha \geq 3$- The existence of primitive roots mod p for odd primes p- Primitive roots and quadratic residues – The existence of primitive roots and P^a- The existence of primitive roots mod 2 P^a –The nonexistence of Primitive roots in the remaining cases- The number of primitive roots mod m.

(Text 1, Sections 10.1-10.9)

Introduction to Cryptography; From Caesar Cipher to Public Key Cryptography-The Knapsack Crypto system- An application of primitive roots to Cryptography.

(Text 2, Sections 10.1-10.3)

Unit III

Algebraic Backgrounds: Symmetric polynomials- modules- free abelian groups
(Text 3, Section 1.4-1.6)

Algebraic Numbers: Algebraic numbers- Conjugates and Discriminants- Algebraic integers- Integral bases- Norms and Traces- Rings of integers.
(Text 3, Section 2.1-2.6)

Quadratic and Cyclotomic fields: Quadratic fields-Cyclotomic fields.

(Text 3, Sections 3.1-3.2)

Reference:

1. G.H Hardy and E.M Wright: An introduction to the theory of numbers, Oxford University Press.
2. I Niven, H.S Zuckerman, H.L Montgomery; An Introduction to the theory of numbers, Wiley India
3. Emil Grosswald: Introduction to number theory.
4. P.Samuel; Theory of Algebraic Numbers, Herman Paris Haught on Mifflin
5. S.Lang Algebraic Number Theory Addison Wesley Pub.Co Reading.

MAF3C12 FUNCTIONAL ANALYSIS

Text Book; Balmohan V Limaye; Functional Analysis (2nd Edition); New Age International Publishers.

Unit I

Fundamentals of Normed Spaces; Normed Spaces, Banach spaces, Continuity of Linear Maps, Hahn-Banach Theorems.

(Chapter-2, Sections 5,6,7,8)

Unit II

Bounded Linear Maps on Banach Spaces; Uniform Boundedness Principle, Closed Graph and Open Mapping Theorems, Bounded Inverse Theorem

(Chapter-3, Section 9, 10, 11, Omit Quadrature Formula and Matrix Transformation and Summability Methods of Section 9)

Unit III

Geometry of Hilbert Spaces; Inner Product Spaces, Orthonormal Sets. Approximation and Optimization, Projection and Riesz Representation Theorems.

(Chapter-6, Section 21,22, 23, 24 (Omit 23.2, 23.6, 24.7, 24.8))

Reference:

1. E.Kreyszig; Introductory Functional Analysis with Applications, John Wiley
2. Walter Rudin; Functional Analysis, TMH Edtions1978
3. M.T Nair; Functional Analysis A First Course; Prentice Hall of India.
4. Chaudhary and Sudarsan Nanda; Functional Analysis with Applications, Wiley Eastern Ltd.
5. Walter Rudin; Introduction to Real and Complex Analysis, McGraw Hill International Edition
6. J.B Conway; Functional Analysis, Narosa Publishing Company
7. Bachman and Narici; Functional Analysis

MAF3C13 COMPLEX FUNCTION THEORY

Text Book 1: Lars V Ahlfors -Complex Analysis (3rd Edition), Mc Graw-Hill Education

Text Book 2: John B Conway - Functions of One Complex Variable, 2nd Edition, Springer International Student Edition.

UNIT I

Elliptic Functions: Simple periodic functions, Doubly periodic functions, The Weierstrass Theory. (Chapter 7, Sections 1, 2, 3 of Text 1)

The Riemann Zeta function (Chapter 7, Sections 8 of Text 2)

UNIT II

Runge's Theorem: Runge's Theorem, Simple Connectedness, Mittag Lefler's Theorem.

Analytic Continuation and Riemann Surfaces: Schwarz Reflection Principle, Analytic Continuation along a path, Mondromy Theorem

(Chapter VIII, Section 1, 2, 3, of text 2; IX Section 1, 2, 3 of text 2)

UNIT III

Harmonic Functions: Basic Properties of harmonic functions, Harmonic functions on a disk, Sub harmonic and super harmonic functions.

Entire Functions: Jensen's formula.

(Chapter X, Sections 1,2,3 ; Chapter XI, Sections 1 of Text 2)

References

1. Louis Pennise: Elements of Complex Variable Half, Richart & Winston 1976
2. Silverman. H:Complex Variable, Haughton Miffin Complex, Boston 1975.
3. Rudin.W: Real and Complex Analysis (3rdEdition) McGraw Hill International Edition1967
4. E.T Copson: An Introduction to the Theory of a Complex Variables, Oxford University Press1974.

MAF3C14 MULTIVARIATE CALCULUS

Text Book: Walter Rudin: Principles of Mathematical Analysis; (3rd Edition) Mc. Graw Hill, 1986.

Unit 1

Sequence and series of Functions: Discussion of Main Problem, Uniform Convergence, Uniform Convergence Continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinous Family of Functions, The Stone-Weierstrass Theorem.
(Chapter-7; Sections 7.1 to 7.33 and Theorem 7.33)

Unit 11

Some Special Functions; Power Series, The Exponential and Logarithmic Functions, The Trigonometric Functions, The Algebraic Completeness of the Complex Field, Fourier Series.
The Gamma Function.
(Chapter-8: Sections 8.1 to 8.22)

Unit 111

Functions of Several Variables: Liner Transformations, Differentiation The Contraction Principle, The Inverse Function Theorem, The Implicit Function Theorem.
(Chater-9; Sections 9.1 to 9.29)

Reference:

1. R.G Bartle and D. RSherbert; Introduction to Real Analysis; JohnWiley Bros.1982
2. L.M Graves; The Theory of Functions of a Real Variable; Tata McGraw- Hill Book Co1978
3. M.H Protter and C.B Moray; A First course in Real Analysis; Springer Verlag UTM1977
4. T.M Apostol; Mathematical Analysis; 2nd Edition; Narosa Publications 1973

MAF4C15 Financial Risk Management

Text : Michael B Miller, Quantitative Financial Risk Management, Willey Finance Series

Module 1

Overview of Financial Risk Management
What is Risk?, What is Financial Risk Management?, Types of financial Risks, What does a risk manager do?, A very brief history of Risk Management, The future of Risk Management.
Market Risk : Standard deviation
Averages, Expectations, Variance and Standard Deviation, Standard Deviation with Decay, Garch, Moments, Skewness, Kurtosis, Jump – Diffusion Model, Dollar Standard Deviation, Annualization
Market Risk: Expected Shortfall, and Extreme Value Theory
Coherent Risk Measures, Expected Shortfall, Extreme Value Theory

Module 2

Credit Risk
Default Risk and Pricing, Determining the Probability of Default, Portfolio Credit Risk, Reducing Credit Risk
Liquidity Risk
What is Liquidity Risk, Simple Liquidity Measures, Liquidity Cost Models, Optimal Liquidation.

Module 3

Bayesian Analysis
Conditional probability, Overview of Bayasian Analysis, Bayes' Theorem, Bayesians versus Frequentists, Many – State Problems, Continuous Distributions, Bayesian Networks, Bayesian Networks Versus Correlation Matrices.

References

1. Jorion P, Financial Risk Management Handbook, Wiley, 2003
2. Chandra, Prasanna, Financial Management, Tata MacGraw Hill, New Delhi
3. S C Gupta, V K kapoor, Fundamentals of Mathematical Statistics, Sulthan Chand & Sons, New Delhi.
4. Rao C R, Linear Statistical Inference and its Applications, 2nd edition, Wiley, New York
5. Pitman J, Probability, Narosa Publishing House, New Delhi.

MAF4C16 MODELLING & SIMULATION

Text : Gregoire Allaire, Numerical Analysis and optimization – An Introduction to Mathematical Modelling and Numerical simulation, Oxford Science Publications.

Module 1 : Introduction to Mathematical Modeling and Numerical Simulation

General Introduction, An Example of modeling, Some classical models – The heat flow equation, The wave equation, The Laplacian, Schrodinger's equation, The lame equation, The stokes system, The Plate equations, Numerical calculation by finite differences – Principles of the method, Numerical results for the heat flow equation, Numerical results for the advection equation, The idea of a well posed problems, Classification of PDEs.

Module 2 : Finite difference method

Introduction, Finite differences for the heat equation – Various examples of schemes, consistency and accuracy, stability and Fourier Analysis, Convergence of the schemes, Multilevel schemes, The multidimensional case, Other Models – Advection equation , wave equation.

Module 3 :

Variational formulation of elliptic problems

Introduction, Classical formulation, The case of a space of one dimension. Variational approach – Green's formulas, variational formulation.

References

1. Frank R Giordano, Mawrice D Weir, William P Fox, A First Course in Mathematical Modelling, 3rd edition, 2003, Thomson Brooks/Cole, Vikas Publishing House (P) Ltd.

2. Averill M Law, W.David Kelton; Simulation, Modelling and Analysis; Tata McGrawHill

3. Parviz Moin , Fundamentals of Engineering Numerical Analysis, Cambridge University Press

4. Steven C Chapra, Raymond P Canale, Numerical Method for Engineers, McGrawHill

5. S.R.K Iyengar, R K Jain, Numerical Methods, New Age International Publishers

MAF3E01 GRAPH THEORY (Elective 1)

Text 1 J.A Bondy and U.S Murty, Graph Theory with Applications, The MacMillan Press Ltd, 1976

Text 2 John Clark and Derek Allan Holtan, A First Look at Graph Theory, Allied Publishers, Ltd

Unit I

Independent Sets and Cliques; Independent Sets, Ramsey's Theorem, Turan's Theorem, Shur's Theorem

Vertex Colorings: Chromatic Number, Book's Theorem Hajo's Conjecture, Chromatic Polynomials, Girth and Chromatic Number.

(Chapter 7; Except Section 7.5, Chapter 8 Except Section 8.6, Text 1)

Unit II

Edge Colourings: Edge Chromatic Number, Vizing's Theorem, The Timetabling Problem

Planar Graphs; Plane and Planar Graphs, Dual Graphs, Euler's Formula Bridges, Kuratowski's Theorem. The Five Colour Theorem Non Hamiltonian Planar Graphs.

(Chapter 6, All sections; Chapter 9; Except section 9.8 of Text 1)

Unit III

Matchings: Matchings, Matchings and Coverings in bipartite Graphs, Perfect Matchings,The Personnel Assignment Problem, The Optimal Assignment Problem.
(Chapter 5, Sections 5.1, 5.2, 5.3, 5.4, 5.5 of text 1)

Networks; Flows and Cuts, Separating sets

(Chapter 8; Sections 8.1 & 8.3 of text 2

Reference:

1. F. Harraray, Graph Theory, Narosa PublishingHouse.
2. NarasinghDeo,GraphTheorywithapplicationstoEngineeringand Computer Science,PHI.
3. O.Ore, Graph and Their uses, Random House Inc, NY(1963)
4. K.D Joshi, Foundations of Discrete Mathematics, WileyEastern Ltd.

MAF3E02 PROBABILITY THEORY (Elective 1)

Text Book: B.R Bhat: Modern Probability Theory(2nd Edition.); New Age international PVT. Ltd. New Delhi1999)

Unit I

Sets and Classes of Events, Random Variables, Probability Spaces
(Chapter -1: Sections 1.1 to 1.4; Chapter -2: Sections 2.1 to 2.3; Chapter -3: Sections 3.1 to 3.5)

Unit II

Distribution Functions, Expectation and Moments, Convergence of Random Variables
(Chapter- 4: Sections 4.1 to 4.4; Chapter -5: Sections 5.1 to 5.3; Chapter -6: Sections 6.1 to 6.6)

Unit III

Characteristic Functions, Convergence of Distribution Functions.

(Chapter-7: Sections7.1to7.5, Chapter-8: sections8.1to 8.3)

References:

1. P. Billingsley: Probability and Measure, John Wiley & Sons NY(1979)
2. K.I Chung : Elementary Probability Theory with Stochastic Process Narosa Publishing House New Delhi (1980)
3. W. Feller : An Introduction to Probability Theory and its Applications Vol 1 & 2, John Wiley & Sons NY (1968,1971)
4. E. Parzen : Modern Probability Theory and its Applications, Wiley Eastern Ltd, New Delhi(1972)
5. H.G Tucker: A Graduate Course in Probability, Academic Press NY(1967

MAF3E03 CALCULUS OF VARIATIONS (Elective 1)

Text Book:I M. Gelfand and S.V Fomin; Calculus of Variations, Prentice Hall Inc, N.Y (1963)

Unit I

Elements of the Theory, Further Generalizations

(Chapter-1, all Sections ; Chapter-2 all Section)

Unit II

General Variations of a Functional, The Canonical Form of the Euler Equations and related topics

(Chapter-3 All sections; Chapter-4 All sections)

Unit III

The Second Variation, Sufficient condition for a Weak Extremum

(Chapter-5 All sections)

Reference:

1. Bliss G.A Calculus of Variations, Open Court Publishing Co. Chicago (1925)
2. Bolza O Lecture on Calculus of Variations,G.E Stinchar & Co.NY (1931)
3. CourantR and Hilbert D; Methods of Mathematical Physics,Vol.1 Wiley Eastern Reprint(1975)
4. Elsgoltz I; Differential Equations and Calculus of Variations, Mr Publishers Moscow(1973)
5. Morse M. The Calculus of Variations, American Mathematical Society (1934)

MAF4E01 OPERATOR THEORY (Elective 2)

Text Book: Balmohan V Limaye; Functional Analysis (2nd Edition); New Age International Publishers

Unit I

Spectrum of a Bounded Operator-Spaces of Bounded Linear Functionals; Duals and Transposes Weak and Weak* Convergence
(Chapter-3 Section-12; Chapter-4 Sections 13; 13.1 to 13.6 and Sections 15; 15.1 to 15.4)

Unit II

Spaces of Bounded Linear Functionals; Reflexivity, Compact Operators on Normed Spaces: Compact Linear Maps, Spectrum of a Compact Operator.
(Chapter-4, Section 16; Chapter-5, Sections 17,18)

Unit III

Bounded Operators on Hilbert Spaces; Bounded Operators and Adjoints, Normal, Unitary and Self Adjoint Operators, Spectrum and Numerical Range, Compact Self Adjoint Operators.

(Chapter-7; Section 25, 26(omit 26.6) and 27and 28; 28.1 to 28.4 and 28.5 Statement only)

Reference:

1. E.Kreyszig; Introductory Functional Analysis with Applications, John Wiley
2. Walter Rudin; Functional Analysis, TMH Edtion1978.
3. M.T Nair: Functional Analysis A First Course: Prentice Hall of India
4. Chaudhary and Sudarsan Nanda: Functional Analysis with Applications, Wiley Eastern Ltd.
5. Walter Rudin: Introduction to Realand Complex Analysis, McGraw Hill International Edition
6. J.B Conway: Functional Analysis, Narosa Publishing Company

. 7. Bachman and Narici; Functional Analysis

MAF4E02 DIFFERENTIAL GEOMETRY (Elective 2)

Text Book: John A Thorpe: Elementary Topics in Differential Geometry, Springer Verlag NY Heidelberg, Berlin

Unit I

Graphs and Levels Sets, Vector Fields, The Tangent Space, Surfaces, Vector fields on Surfaces, Orientation
(Chapter 1,2,3,4,5)

Unit II

The Gauss map, Geodesics, Parallel Transport, The Weingarten Map, Curvature of Plane Curves.
(Chapter 6,7,8,9,10)

Unit III

Are Length and Line Integrals, Curvature of Surfaces, Parameterized Surfaces, and Local Equivalence of Surfaces and Parameterized Surfaces.
(Chapter 11,12,14,15)

Reference:

1. WI Burko: Applied Differential Geometry, Cambridge University Press (1985)
2. M. De Carmo Differential Geometry of Curves, Surface s(Prentice Hall Inc. Englewood cliffs N.J(1976)
3. V.Grilleman and Pollack :Differential Topology, Prentice Hall, Inc Englewood cliffs N.J(1974)
4. Singer and J. A Thorp: Lecture notes on elementary Topology and Geometry CUTM Springer Verlag, New York (1967)
5. R. Millmen and Parker: Elements of Differential Geometry(Prenice Hall Inc. Englewood cliffs N.J(1977)
6. M Spivak: A Comprehensive Introduction to Differential Geometry,Vol1 to 5, Perish Boston(1970-75)

MAF4E03 OPERATIONS RESEARCH (Elective 2)

Text Book; Kanti Swarup, P.K Gupta, Man Mohan; Operations Research; Sultan Chand & Sons. New Delhi (2007)

Unit I

Markov Analysis, Decision Analysis, Simulation

(Chapter-15; All Sections; Chapter-16; All Sections; Chapter-22; Section 22.1 to 22.9)

Unit II

Reliability and System failure rates, Inventory Control

(Chapter-18; Section 18.6, Chpater-19; All Sections, expect 19.8 and 19.9)

Unit III

Information Theory (Chpater-30; Section 30.1 to 30.10)

Reference:

1. K.V Mittal; Optimization methods on Operations Research and System Analysis, New Age International (P) Ltd. New Delhi
2. J.K Sharma; Operations Research-Theory and Applications ,Macmillan, New Delhi
3. R.K Gupta; Operations Research, Krishna Prakashan Mandir II, Shivaji Road,Meerat-2,
4. L.R Potti; Operations Research, Yamuna Publications, Sreekanteswaram, Thiruvananthapuram
5. Premkumar Gupta and D.S Hira; Operations Research, S. Chand& Company Ltd. Ram Nagar New Delhi1995.
6. B.S Goeland S.K Mittal; Operations Research, Pragti Prakashan Meerat-2

First Semester M.Sc Mathematics Degree Examination
Model Question Paper
MAF1C01 Basic Abstract Algebra

Time: Three Hours Maximum : 80 Marks

Part A

Answer four questions from this part.

Each question carries 4 marks.

1. Are the groups $\mathbb{Z}_2 \times \mathbb{Z}_{12}$ and $\mathbb{Z}_4 \times \mathbb{Z}_6$ isomorphic ? Why or why not ?.

2. Let X be a G-set. Then prove that G_x is a subgroup for each $x \in X$

3. Prove that no group of order 20 is simple.

4. Is $\{(2,1), (4,1)\}$ a basis for $\mathbb{Z} \times \mathbb{Z}$? Prove your assertion.

5. Factorize $f(x) = x^4 + 3x^3 + 2x + 4$ in $\mathbb{Z}_5[x]$.

6. Find all $c \in \mathbb{Z}_3$ such that $\mathbb{Z}_3[x] / \langle x^2 + c \rangle$ is a field.

Part B

Answer **4** questions from this part without omitting any Unit. Each question carries **16** marks.

UNITI

7. (*a*) Prove that direct product of abelian groups is abelian.

   (*b*) Prove that $\mathbb{Z}_m \times \mathbb{Z}_n$ is isomorphic to $\mathbb{Z}_m$ if and only if gcd$(m, n) = 1$.

8. (*a*) Let X be a G-set and let $x \in X$. Then prove the following:

   (i) $|Gx| = (G : G_x)$

   (ii) If G is finite then $|Gx|$ is a divisor of $|G|$

   (*b)* Prove Cauchy's theorem for groups.

9. (a) Prove that every group of prime power order is solvable.

   (b) Prove that for a prime number p, every group of order p^2 is abelian.

UNIT I I

10. (a) Prove that any two fields of quotients of an integral domain D are isomorphic.

(b) Find the elements of $\mathbb{Z}$ that makes up the field of quotient of

$$D = \{n + mi : n, m \in \mathbb{Z}\} \text{ in } \mathbb{Z}$$

11. (a) State and prove second isomorphism theorem.

(b) Prove that two subnormal series of a group G have isomorphic refinements.

12. (a) If G is a nonzero free abelian group with a finite basis of r elements, then prove that G is isomorphic to $\mathbb{Z} \times \mathbb{Z} \times \ldots \times \mathbb{Z}$ for r factors.

(b) Prove that every finitely generated abelian group is isomorphic to a group of the form $\mathbb{Z}_{m_1} \times \mathbb{Z}_{m_2} \times \ldots \times \mathbb{Z}_{m_r} \times \mathbb{Z} \times \ldots \times \mathbb{Z}$ where m_i divides m_{i+1} for $i = 1, 2, \ldots, r-1$.

UNIT III

13. (*a*) Prove Evaluation homomorphism theorem.

(*b*) Prove that $R[x]$ is a ring if R is a ring.

14. (*a*) Prove Eisenstein criteria.

(b) Prove that the cyclotomic polynomial is irreducible over $\mathbb{Z}$.

15. (*a*) Prove that R/M is a field if and only if M is a maximal ideal of R.

(*b*) Prove that and ideal $\langle p(x) \rangle \neq \{0\}$ of $F[x]$ is maximal if and only if p(x) is irreducible over F.

First Semester M.Sc Mathenatics Degree Examination
Model Question Paper
MAF1C02 Linear Algebra

Time: 3hrs. Max.Mark:80

Part A

Answer four questions form this part
Each questions carries 4 marks

1. Does there exists a linear transformation T: $R^3 \rightarrow R^3$ such that T(1,0,1)=(1,1), T(-1,-1,0)= (1,2) and T(0,1,1)=(2,1) ? Why?

2. Let T: $R^3 \rightarrow R^3$ be defined by T(x,y)=(x+y, 2x). Find the matrix of T with respect to the usual basis of R^2.

3. Let V=R^3 and S= {(1,0,0),(1,1,0)}. Find the annihilator S^o?

4. Prove that if T is a linear operator on F^n such that T^2=T, where F is either C or R, then T is diagonalizable.

5. Prove that the T-Cyclic subspace z($\propto$:T) is one dimensional if and only if $\propto$is a characteristic vector for T.

6. Let V be a inner product space and let x ε V prove that if <x,y>=0 for all yεV thenx=0.

Part B

Answer any four questions from this part without omitting any unit.
Each question carries 16 marks.
Unit – I

7. a) Let V and W be vector spaces over the field F and let T be a linear transformation from V into W. Prove that if V is finite dimensional, then rank(T) + nullity T = dim V
b) Find a basis for the space L(R^2, R^3) over R.

8. a) Let B and B' be two ordered bases for an n dimensional vector space V over the field F and T be a linear operator on V. Then prove that there exist an invertible nxn matrix P over F such That $[T]_{B'} = D^{-1}[T]_B P$

   b) Find range an null space of the linear operator T(a,b,c)=(a+b,2c,0) on R^3.

9. a)Let V be a finite dimensional vector space over a field F. Let{$e_1, e_2, \ldots\ldots, e_n$}be a basis of V. Describe the dual basis and show that it is a basis for the dual space V*.
b) Let V=R^3 over R. Give a basis for V and give the dual basis.

Unit- II

10. a) Prove the Cayley-Hamilton theorem.

    b) Let A and B be nxn matrices over a field F. Prove that if I-AB is invertible then I-BA is also invertible. Deduce that AB and BA have the same characteristic values.

11. a) Let T be a linear operator on an n-dimensional vector space V. Then prove that the characteristic and minimal polynomials for T have same roots, except for multiplicities.

    b) Find the minimal polynomial for A= $\begin{matrix} 1 & 1 & 0 & 0 \\ -1 & -1 & 0 & 0 \\ -2 & -2 & 2 & 1 \\ 1 & 1 & -1 & 0 \end{matrix}$

12. a) State and prove a necessary and sufficient condition for a linear operator on a finite dimensional vector space to be triangularly.

    b) Find an invertible matrix P such that P^{-1} AP is a diagonal matrix,

    where A= $\begin{matrix} -1 & 1 \\ 1 & 1 \end{matrix}$

Unit III

13. a) State and prove primary decomposition theorem.

    b) if $T(x_1,x_2)= (2x_1, x_2, -x_1)$ find a diagonalizable operator D and a nilpotent operator N on R^2 such that T=D+N

14. a) Define a cyclic vector for a linear operator Tof a vector space. If a linear operator T of a finite dimensional vector space has a cyclic vector show that dim V is the same as the degree of the minimal polynomial of T.

    b) Let T has a diagonalizable operator of n-dimensional vector space. If T has a cyclic vector show that T has r distinct characteristic values.

15. a) Define an inner product space. Prove thatan orthogonal 41etoff non-zero vector in an inner product space is linearly independent.

    b) If W is a finite – Dimensional subspace of an inner product space V then show that $V=W\oplus W^{\perp}$ where is the orthogonal complement of $W^{\perp}$ in V.

First Semester M.Sc Mathematics
Degree Examination
Model Question Paper
MAF1C03 Mathematical Analysis

Time: 3hrs **Max.Marks: 80**

Part A

Answer four questions form this part
Each questions carries 4 marks

1. Verify whether d(x,y) = $\frac{|x-y|}{1+|x-y|}$ x, y in R, is a metric on R
2. Let f and g be continuous mappings of a metric space X into a metric space Y and E a dense subset of X. If f (p) = g(p) for all p in E, prove that f (p) = g (p) for all p in X.
3. Show that L' Hospital's rule does not hold for vector-valued functions.
4. If f (x) = $|x|^3$ compute $f^1(x)$, $f^2(x)$, for all real x. Show that $f^3(0)$ does not exists.
5. Examine whether the function given by f(x) = $x^2 \sin(\frac{1}{x})$, for x $\neq$0, f(0) =0 is of bounded variation on [0, 1]
6. f$\geq$0 is continuous on [a,b]and $\int_a^b f$ =0 show that f = 0

Part B

Answer any four questions from this part without omitting any unit.
Each question carries 16 marks.
Unit – I

7. Show that for a subset E of R^k, following statements are equivalent
   i) E is closed and bounded
   ii) E is compact
   iii) Every infinite subset of E has a limit point in E.
8. a) Let P be a nonempty perfect set in R^k. Show that P is uncountable.
   b) Show that a subset E of the real lime R is connected if and only if x, y in E and x<z<y implies that z in E.

9. a) Show that a continuous function f from a compact metric space X into a metric space Y is uniformly continuous on X.

b) Let f be monotonic on (a, b). Show that the set of point of (a, b) at which f is discontinuous is at most countable.

Unit – II

10. a) State and prove the Taylor's Theorem

b) Let f be a continuous mapping of [a, b] into R^k which is differentiable in (a, b) show that there exists x in (a, b) such that $f|(b)-f(a)| \leq (b-a)|f^1(x)|$

11. a) State and prove the generalized mean value theorem.

b) If f is monotonic on [a, b] and α is continuous on [a, b] show that f is in R(α)

12. a) If f, g in R(α) show that f + g in R(α) and $\int (f+g)\,d\alpha = \int f\,d\alpha + \int g\,d\alpha$

b) Let f be of bounded variation on [a, b], α is monotonically increasing and α^1 in R[a, b]. Show that $\int f\,d\alpha = \int_a^b f(x)\alpha'(x)\,dx$

Unit – III

13. a) Let f:[a, b] → R^k and →f in R(α) for some monotonically increasing function α on [a, b].Show that |f| in R(α) and $\left|\int_a^b f\,d\alpha\right| \leq \int_a^b |f|\,d\alpha$

b) Let f be continuous on [a,b] show that f is of bounded variation on [a,b] if and only if f can be expressed that difference of tow increasing continuous functions.

14. a) Let F and G be differentiable functions on [a, b] such that F^1 = f in R and G^1 = g in R. Show that

$$\int_a^b F(x)g(x)\,dx = F(b)G(b) - F(a)G(a) - \int_a^b f(x)G(x)\,dx$$

b) If f is of bounded variation on [a, b], show that f is bounded on [a, b]

c) Let f be a rectifiable path on [a, b] of are length $\Lambda_f(a,b)$ and c in (a, b). Show that $\Lambda_f(a,b) = \Lambda_f(a,c) + \Lambda_f(c,b)$

15. a) Let f be a monotonic function on [a, b]. Show that f is of bounded variation on [a. b]

b) Let f: [a, b] → R^n be a path with components f =(f_1, f_2,.............f_n) Show that f is rectifiableif and only if each component f_k is of bounded variation on [a, b].

First Semester M.Sc Mathematics Degree Examination
Model Question Paper
MAF1C04 BASIC T O P O L O G Y

Time: Three Hours Maximum : 80 Marks

Part A

Answer **four** *questions from this part.*
Each question carries **4** *marks.*

1 Give six topologies on the set {1, 2,3}.

2 Prove that in a metric space every convergent sequence is a Cauchy sequence. Is the converse true? Justify your answer with an example.

3 Let $X = \{1, 2, 3\}$, $\tau = \{\emptyset, \{1\}, \{1, 2\}, X\}$, $Y = \{4, 5\}$, and $U = \{\emptyset, \{4\}, Y\}$. Give a basis for the product topology on $X \times Y$.

4 For each natural number number n, let $X_n = R$ and let τ_n be the discrete topology on X_n. Let τ be the product topology on $X = \prod_{n\in N} X_n$. Is τ the discrete topology on X ? Either prove that it is or show by example that it is not.

5 Let (X, τ) be a topological space and define a relation $\sim$ on X by $x \sim y$ provided there is a Pathwise connected subset A of X such that $x, y \in A$. Prove that $\sim$ is an equivalence relation on X.

6 Let A be a subset of a topological space (X, τ). Prove that A is compact if and only if every cover of A by members of τ_A has a finite subcover.

Part B

Answer **four** *questions from this part without omitting any Unit.*
Each question carries **16** *marks.*

UNITI

7. (*a*) Prove that the topology generated by the square metric on R^2 is the usual topology.

(b) Describe cocountable topology.

(c) State and prove the necessary and sufficient condition for a subset of the power set be a basis for a topology on X.

8. (a) Let X = {1, 2, 3, 4, 5}. Find the topology with S = {{1},{1, 2, 3}, {2, 3, 4}, {3, 5} } as a subbasis.

(b) Prove that every metric space is first countable.

(c) Let τ be the usual topology on R. Prove that B = {(a, b) : a < b and a and b are rational} is a countable basis for basis for τ .

9 (a) Prove that a subset A of a topological space (X, τ) is a perfect set if and only if it is closed and has no isolated points.

(b) Let (X, d) be a metric space such that every Cauchy sequence in X has a convergent subsequence. Then prove that (X, d) is complete.

(c) Prove that metrizability is a topological property.

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UNIT I I

10. (*a*) Prove that every subspace of a separable metric space is separable.

(b) Define product topology of two topological spaces. Give an example.

(c) Let (X, τ) , (Y_1, U_1) and (Y_2, U_2) be topological spaces, let $f_1 : X \to Y_1$ and $f_2 : X \to Y_2$ be functions, and define $f : X \to Y_1 \times Y_2$ by $f(x) = (f_1(x), f_2(x))$. The show that f is continuous if and only if f_1 and f_2 are continuous.

11. (*a*) Let $\{(X_\alpha, \tau_\alpha) : \alpha \in \Lambda\}$ be an indexed family of topological spaces, and for each $\alpha \in \Lambda$, let B_α be a basis for τ_α. Then prove that the collection B of all sets of the form $\prod_{\alpha\in\Lambda} B_\alpha$, where $B_\alpha = X_\alpha$ for all but a finite number of members $\beta_1, \beta_2, \ldots, \beta_n$ of Λ and $B \in B$ for each $_i$ $_i$ $i = 1, 2, \ldots, n$ is a basis for the product topology τ on $\prod_{\alpha\in\Lambda} X_\alpha$.

(b) Let $\{(X_\alpha, \tau_\alpha) : \alpha \in \Lambda\}$ be an indexed family of first countable spaces, and let $X = \prod_{\alpha\in\Lambda} X_\alpha$. Then

(c) (X, τ) is first countable if and only if τ_α is the trivial topology for all but a countable number of α.

12. (*a*) Let (X, τ) and (Y, V) be topological spaces, let f be a continuous function that maps X onto Y, and let U be the quotient topology on Y induced by f. Prove that if f is open or closed, then $U = V$.

(b) Prove that the composition of two quotient maps is a quotient map.

(c) Suppose R has the usual topology. Define an equivalence relation ~ on R by $a \sim b$ provided there is an even integer k such that $a - b = k\pi$. Let D be the set of all equivalence classes, and let U be the quotient topology on D induced by the function that maps each member of R into the equivalence class that contains it. Describe the quotient space (D, U).

UNIT I I I

13. (a) When we say that a subset of a topological space is compact? Give one example.

(b) If X is an infinite set and τ is the discrete topology on X, then prove that (X, τ) is not compact.

(c) Prove that every totally bounded metric space is bounded.

14. (*a*) Prove that every countable compact space has the Bolzano-Weierstrass property.

(*b*) Prove that a metric space is compact if and only if it is closed and bounded.

15. (a) Prove that compactness is a topological property.

(b) Prove that product of two compact spaces is compact.

(c) Let (X, τ) be a compact space and let $f : X \to R$ be a continuous function. Then prove that there exist $c, d \in X$ such that for all $x \in X$, $f(c) \leq f(x) \leq f(d)$.

First Semester M.Sc Mathematics
Degree Examination
Model Question Paper
MAF1C05 Differential Equations

Time: ThreeHours | Maximum : 80 Marks

Part A

Answer **four** *questions from this part.*
Each question carries **4** *marks.*

1. Define F (a,b,c,x).Show that, $F(a,b,c,x) = \frac{ab}{c} F(a+1,b+1,c+1,x)$
2. Determine the nature of the point x = 0 for the differential equation y"+ (sin x)y =0

3. Obtain the recursion formula: $(n+1)p_{n+1}(x)(2n+1)p_n(x)(x) \quad - n\,p_{n-1}$

4. Prove that the positive roots of $J_p(x)$ and $J_{p+1}(x)$ occur alternately, in the sense that between each pair of consecutive positive zeros of either there is exactly one zero of the other.

5 Show that (0,0) is an asymptotically stable critical point for the system

$$\frac{dx}{dt} = -3x^3 \qquad ; \frac{dy}{dt} = x^5 - 2y^3$$

6. Define Lipschitz condition. Show that $f(x,y) = xy$ satisfies the Lipschitz condition on any strip $a \leq x \leq b ; -\infty < y < \infty$

PART-B

Answer four questions from this part without omitting any Unit.
Each question carries 16 marks.

UNIT I

7. a) Show that the series $y = 1 - \frac{x^2}{2^2} + \frac{x^4}{2^2.4^2} - \frac{x^6}{2^2.4^2.6^2} + \cdots$ converges for all x and verify that it is a solution of the equation $xy'' + y' + xy = 0$

b) Show that $\tan x = x + \frac{1}{3}x^3 + \frac{2}{15}x^5 + \cdots$ by solving $y' = 1 + y^2$, $y(0) = 0$ in two ways.

8 a) Find the general solution of the equation $4x^2y'' - 8x^2y' + (4x^2+1)y = 0$

b) Find the general solution of the equation

$(1-e^x)y'' + \frac{1}{2}y' + e^x y = 0$ near the singular point $x = 0$

9 a) Find two linearly independent solution of the Chebyshev equation $(1-x^2)y'' - xy' + p^2y = 0$, where p is a constant.

b) Prove that Hermite polynomials are orthogonal.

UNIT II

10. a) Solve the Legendre equation $(1-x^2)y'' - 2xy' + p(p+1)y = 0$

b) Show that i) $2J_p'(x) = J_{p-1}(x) - J_{p+1}(x)$

ii) $\frac{2p}{x}J_p(x) = J_{p-1}(x) + J_{p+1}(x)$

11 a)If $P_m(x), P_n(x)$ are Legendre Polynomials, Provethat

$$\int_{-1}^{1} P_m(x)P_n(x)\,dx = \begin{cases} 0 & if\ m \neq n \\ \frac{2}{2n+1} & if\ m = n \end{cases}$$

b) Prove that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x$

12. a) Find the general solution of the following system of equations

$$\frac{dx}{dt} = x + y - 5t + 2, \quad \frac{dy}{dt} = 4x - 2y - 8t - 8$$

b) Find the general solution of the following system of equations

$$\frac{dx}{dt} = 4x - 2y,\ \frac{dy}{dt} = 5x + 2y$$

UNIT III

13.a) Find the critical points, the differential equation of the path and solve the differential equation to find the path for the system $\frac{dx}{dt} = y(x^2+1),\ \frac{dy}{dt} = 2xy^2$

b) State Liapunov stability theorem. Show that the function, $E(x, y) = ax^2 + bxy + cy^2$ is positive definite if and only if $a > 0$ and $b^2 - 4ac < 0$ and negative definite if and only if $a < 0$ and $b^2 - 4ac < 0$.

14. a) Verify that (0,0) is a simple critical point for the system

$$\frac{dx}{dt} = -x - y - 3x^2y,\ \frac{dy}{dt} = -2x - 4y + y\sin x$$

b) Determine the nature and stability properties of the critical point (0,0) for the system

$$\frac{dx}{dt} = -4x \qquad \frac{dy}{dt} = yx - 2y$$

15. State and Prove Picard's Theorem

Second Semester M.Sc Mathematics

Degree Examination

Model Question Paper

MAF2C06 Advanced Abstract Algebra

Time: Three Hours Maximum : 80 Marks

Part A

Answer four questions from this part.

Each question carries 4 marks.

1. Prove that in a PID an irreducible is a prime.
2. Find a gcd of 8+6i and 5-15i in$Z[i]$
3. Prove that $3\sqrt{2\sqrt{\ }}$ is an algebraic number.
4. Find the number of primitive 18th unity in GF(9).
5. Find the fixed field of $Q(\sqrt{2},\sqrt{3})$ over Q .
6. What is the order of$G\left(Q\left(^{3}\quad \backslash Z_2\right)\right)\sqrt{?}$

Part B

Answer **4** questions from this part without omitting any Unit. Each question carries **16**marks.

UNITI

7. (*a*) Prove Guass Lemma.

   (*b*) Define UFD and show $Z\left[\sqrt{-}\right]$is not a UFD.

8. (*a*) Prove the ascending chain condition for a PID.

   (*b*) Prove that an ideal $<p>$in a PID is maximal iff p is an irreducible.

9. (a) Let p be an odd prime. Prove that $p = a^2+b^2$for integers a and b in Z if and only if $p \equiv 1 (\text{mod } 4)$

   (b) State and prove Knonecker's theorem.

UNIT I I

10. (a) Prove that the set of all constructible real numbers forms a subfield of Z .

    (b) Prove that doubling the cube is impossible.

11. (a) Prove that a finite extension field E of field F is an algebraic extension of F.

12. (*a*) If E is a finite field of characteristic p, then prove that then E contains exactly p^n elements for some positive integer n.

(*b*) Prove that complex zeros of polynomials with real coefficients occur in conjugate pairs.

UNIT III

13. State and prove isomorphism extension theorem.

14. (*a*) Define splitting field, give an example.

(*b*) Prove that A field E, where $F \leq E \leq \overline{F}$ is a splitting field over F iff every automorphism of $\overline{F}$ leaving F fixed maps E onto itself and thus induces an automorphism of F fixed.

15. (*a*) Prove that A field is perfect if every finite extension is a separable extension.

(*b*) State and prove primitive element theorem.

Second Semester M.Sc Mathematics Degree Examination
Model Question Paper
MAF2C 07 Measure and Integration

Time: 3hrs **Max.Mark:80**

Part A

Answer four questions form this part
Each questions carries 4 marks

1. Show that outer measures is translation invariant
2. If E_1 and E_2 are measurable sets, show that $m(E_1 \quad E_2) + m(E_1 \quad E_2) = m(E_1) + m(E_2)$
3. Let f be the function defined by $f(0) = 0$ and $f(x) = x \sin \frac{1}{x}$ if $x \neq 0$
   Find $D^+f(0)$ and $D\text{-}f(0)$
4. Show that the monotone convergence theorem need not hold for decreasing sequence of functions.
5. Prove that if ϑ is a signed measure such that $\vartheta \ll \mu$ then $\vartheta = 0$
6. State Hahn Decomposition Theorem. Is it unique verify

Part B

Answer any four questions from this part without omitting any unit.
Each question carries 16 marks.

Unit – I

7. a) Show that the collection $\mathfrak{M}$ of measurable sets is a σ - algebra.
   b) Define a measurable function and show that the sum of two measurable functions is measurable.
8. State and prove Fatous Lemma. Show that strict inequality may hold in fatous Lemma.
9. a) Construct a non measurable set
   b) Prove linearity property of integrals for measurable functions.

Unit – II

10. a) State and prove Dominated convergence Theorem
    b) If is continuous on [a, b] then show that f is integrable and $F(x) = \int_a^x f(t)\,dt$ then prove that $F^1(x) = f(x)$ for almost all x in [a.b]

11. If f is Reimann Integrable and bounded on [a. b] show that f is integrable &R $\int_a^b f\,dx \quad \int_a^b f\,dx$ .Verify converse does not hold.

12. a) Define 1) Complete measure 2)σ – finite measure

    b) if μ is a σ finite measure on a ring R, than it has a unique extension to the σ ring s(R)

Unit – III

13. a) Define measure space and measurable space, Give Example

    b) State and prove monotone convergence theorem

14. a) Verify Holder's inequality

    b) Verify Minkowski's inequality

15. Prove completeness of L^p(μ)

.

Second Semester M.Sc Mathematics
Degree Examination
Model Question Paper
MAF2C08 Advanced Topology

Time: ThreeHours Maximum :80Marks

Part A

Answer **four** *questions from this part.*
Each question carries **4** *marks.*

1. Prove that every subspace of a T_2 space is a T_2space.
2. Give an example of a space that is normal but not regular.
3. Let (X, τ) be a topological space, and p be an object that does not belong to X, and let $Y = X \cup \{p\}$. Prove that $U = \{U \in P(Y) : U \in \tau$ or $Y - U$ is a closed compact subspace of $X\}$ is a topology on$Y$.
4. For each natural number number n, let (X_n, d_n) be a metric space, let $X = \prod_{n \in N} X_n$. Define

∞

$$d(x, y) = \sum_{n=1} \frac{d_n(x_n, y_n)}{2^n}$$

for all $x = (x_1, x_2, \ldots, x_n), y = (y_1, y_2, \ldots, y_n) \in X$. Prove that d is a metric on X.

5. Let (X, τ) be a topological space and let $x_0 \in X$. Prove that Z_p is an equivalence relation on $\Omega(X, x_0)$.
6. Explain the terms covering map and covering space.

Part B

Answer **four** *questions from this part without omitting any Unit.*
Each question carries **16** *marks.*

UNIT I

7. (*a*) Let (X, τ) be a topological space. Then prove that the following statements are equivalent.
   (i) (X, τ) is a T_1 space.
   (ii) For each $x \in X$, $(\{x\})$ is closed.
   (iii) If A is any subset of X, then $A = \bigcap \{U \in \tau: A \subseteq U\}$.

   (*b*) Prove the result: A T_1 space (X, τ) is regular if and only if for each member p of X and each neighborhood U of p, there is a neighborhood V of p such that $\overline{V} \subseteq U$.

8. (*a*) Prove that every compact Hausdorff space is normal.
   (b) Examine whether the Moore plane is normal or not.
   (c) Let C be a closed subset of a normal space (X, τ). Then prove that (C, τ_C) is

normal.

9. (*a*) Prove that every second countable space is Lindelof.

(*b*) Prove that the set of dyadic numbers in $I = [0, 1]$ is dense in *I*.

(c) Prove that a topological space is completely regular if and only if it homeomorhphic to a subspace of a cube.

UNIT I I

10. (*a*) Prove that closed subspace of a locally compact Hausdorff space is locally compact.

(b) Prove that every first countable Hausdorff space is a *k*-space.

(c) Let (X, τ) and (Y, U) be topological spaces and let *F* be a finite set of continuous functions that map *X* into *Y*. Prove that *F* is equicontinuous.

11. (*a*) Prove that every completely regular space has a compactification.

(*b*) Prove that the product of compact spaces is compact.

12. State and prove Urysohn's metrization theorem.

UNIT I I I

13. (*a*) Let (X, τ) and (Y, U) be topological spaces. Then prove that the function homotopy is an equivalence relation on *C(X, Y)*, the collection of continuous functions that map *X* onto *Y*.

(*b*) Let (X, τ) be a topological space, and let $x_0 \in X$. Furthermore, let $\alpha_1, \alpha_2, \beta_1, \beta_2 \in \Omega(X, x_0)$ and suppose $\alpha_1 +_p \alpha_2$ and $\beta_1 +_p \beta_2$. Then prove that $\alpha_1 * \beta_1 +_p \alpha_2 * \beta_2$.

14. (*a*) Let (X, τ) and (Y, U) be topological spaces, let $x_0 \in X$ and $y_0 \in Y$, and let $h : (X, x_0) \to (Y, y_0)$ be a map. Then prove that *h* induces a homeomorphism $h_* : \pi_1(X, x_0) \to \pi_1(Y, y_0)$..

(*b*) Let (X, τ), (Y, U) and (Z, V) be topological spaces, let $x_0 \in X$, $y_0 \in Y$, and $z_0 \in Z$, and let $h : (X, x_0) \to (Y, y_0)$ and $k : (Y, y_0) \to (Z, z_0)$ be maps. Then prove that $(k \circ h)_* = k_* \circ h_*$.

15. (a) Let $\alpha : I \to S1$ be a path and let $x_0 \in R$ such that $p(x_0) = \alpha(0)$. Then prove that there is a unique path $\beta : I \to R$ such that $\beta(0) = x_0$ and $p \circ \beta = \alpha$.

(b) Describe the term covering space of a topological space.

Second Semester M.Sc Mathematics Degree Examination

Model Question Paper

MAF2C09 Foundations of Complex Analysis

Time: 3hrs. **Max.Mark:80**

Part A

Answer four questions form this part Each questions carries 4 marks

1. Derive Cauchy's estimate
2. $F(z) = \frac{1}{z(z-1)(z-2)}$ Give the Laurent Expansion of f(z) in different regions.
3. Find $\int_0^\pi \frac{d\theta}{z+\cos\theta}$ z >1, z is a constant
4. Verify Hurwitz Theorem
5. Derive an application of the Weierstrass factorization to sin πz
6. Define the Gamma function. Derive its functional Equation

Part B

Answer any four questions from this part without omitting any unit.

Each question carries 16 marks.

Unit – I

7. State and prove Liouvilles theorem . Derive fundamental theorem of Algebra
8. Prove Maximum Modulus Theorem
9. a) state and prove open mapping Theorem

   b) State and prove Goursat's Theorem.

UNIT II

10. Derive Laurent series Development

11 a) State and prove Cauchy’s Residue Theorem

b) Show that $\int_{-\infty}^{\infty} dx = \frac{\pi x^2}{1+x^4}$

12 a) State and prove Schwarz’s Lemma

b) State and prove maximum modulus Theorem third version.

Unit – III

13. a) Show that C(G,Ω) is complete metric space

b) Prove A set Ƒ ⊂ C(G, Ω) is normal off its closure is compact

14. Prove Arzela – Ascolis Theorem

15. a) Prove Fundamental criterion for convergence a infinite product

b) Prove Bohr – Moller up Theorem

MODEL QUESTION PAPER

SECOND SEMESTER M.Sc DEGREE EXAMINATION

MAF2C10 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL EQUATIONS

Time 3 hours Maximum Marks80

(PART A)

Answer any four questions from this part.

Each question carries 4 marks.

1. Eliminate the arbitrary function F from $F(x - z) = 0$ and find the corresponding Partial differential equation.
2. Find the Complete integral of the equation $zpq - p - q = 0$
3. Reduce the equation $4u_{xx} - 4u_{xy} + 5u_{yy} = 0$ to Canonical form.
4. Show that the solution of the Dirichlet problem, if it exist, is unique.
5. Show that the integral equation corresponding to boundary value problem, $\frac{d^2y}{dx^2} + \lambda y = 0,\ y(0) = 0,\ y(l) = 0$ is a Fredholm equation of the second kind.
6. Show that characteristic numbers of a Fredholm equation with real symmetric kernel are all real.

PART B

Answer Four questions from this part, without avoiding any unit.

Each question carries 16 marks

UNIT I

7. (a)Let z = F (x, y, a)be a one parameter family of solutions off (x, y,z, p, q) = 0 .Show that this one parameter family, if it exists, is also a solution.

(b) Show that $(x - a)^2 + (y - b)^2 + z^2 = 1$ is a complete integral of $z^2(1 + p^2 + q^2) = 1$

(c) Solve $x^2p + y^2q = (x + y)z$

8. (a) Obtain the necessary and sufficient condition of integrability of the Pfaffian differential equation $\vec{X}.\vec{dr}=P(x,y,z)dx+Q(x,y,z)dy+R(x,y,z)dz =0$

(b) Show that the necessary and sufficient condition for the integrability of

$dz = \varphi(x, y,z)dx + \psi(x, y,z)dy$ is $[f,g] = 0$

9. (a)Solveuxx2− u2− au2= 0usingJacobi'sMethod

(b) Solve xzy− yzx= z, with the initial condition z(x,0) = f (x), x ≥ 0

UNIT II

10. (a) Derive d'Alembert's Solution of Wave Equation.

(b)Derive the Riemann function and hence obtain the solution of $u_{\xi\eta}= 0$

11. (a) State and Prove maximum Principle.

(b) Show that The solution of Neumann problem is unique up to the addition of a constant.

12. (a)Solve the non - homogeneous wave equation u_{tt} with

homogeneous initial conditions $u(x, 0) = u_t(x, 0)$

(b)Solve $u_t= u_{xx}, 0<x <l, t >0, u(0, t)= u(l, t)= 0, u(x, 0)= x(l - x), 0\leq x \leq l.$

UNIT III

13.(a) Solve $y'' + xy = 1, y(0) = 0, y(l) = 1$ using Green's function.

(b) If yn(x) and yn(x) are characteristic functions of $y = \lambda \int_a^b K(x,\xi)y(\xi)d\xi$ corresponding to distinct characteristic numbers , then show that $y_m(x)$ and $y_n(x)$ are orthogonal over the interval (a, b)

14.(a) Show that the non-homogenous Fredholm integral equation of second kind with separable kernel can be reduced to a system of linear algebraic equations and hence show that such equation may have a unique solution or an infinite number of solutions.

(b) Solve the Fredholm integral Equation $y(x) = F(x) + \lambda \int 1(1- 3x\xi)\, y(\xi)d\xi$

15 (a)Describe the iterative method for Solving Fredholm equation of the Second Kind

(b) Solve by iterative method $y(x) =1 + \lambda \int_0^1 (1 - 3x\xi)y(\xi)d\xi$