UNIVERSITY OF CALICUT

SYLLABUS FOR THE M.Sc MATHEMATICS PROGRAMME
UNDER CUCSS – PG – 2014
(Total Credits – 80)

EFFECTIVE FROM 2014 ADMISSIONS

CONTENTS

Major Changes from the Previous Syllabus:

1. Both internal and external evaluation will be carried out in the mark system (indirect grading system) instead of direct grading. After submitting the marks all other calculations in grading are done by the University, using the software.

2. Instead of the General Viva at the end of the programme, Viva Voce of two credits each is introduced in both first and third semesters.

3. Number of credits for Project is 4.

4. In the syllabus following changes are made:
   - (i) Topology is made into a single paper
   - (ii) Functional Analysis is made into a single paper
   - (iii) A new course “Multivariable Calculus and Geometry” is introduced
   - (iv) Differential Geometry paper moved to the elective papers
   - (v) ODE and Calculus of Variation paper is moved to the second semester
   - (vi) Number Theory paper is in the first semester
   - (vii) PDE and integral equations is moved to the third semester
   - (viii) Linear Programming and Applications is replaced by Operations Research paper
   - (ix) Number of Electives increased to four in the proposed syllabus
   - (x) A list of 15 Elective courses are given.

5. A four credit course is for 100 marks (20 internal + 80 end semester examination). Viva Voce is for 50 marks and 100 marks for the Project.

6. Detailed instruction for conducting the (i) Practical (ii) Viva Voce and (iii) Project Viva Voce are given. Also sample mark sheets for all these are given.

7. Detailed Question Paper pattern for the End Semester Examination is given.

8. A Table containing the details of semesterwise marks and total marks is given.

UNIVERSITY OF CALICUT
SYLLABUS FOR THE M.Sc. (MATHEMATICS) PROGRAMME
UNDER CUCSS – PG – 2014

(Total Credits : 80)

EFFECTIVE FROM 2014 ADMISSIONS

Semester I

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MT1C01	**Algebra- I**	**4**	**5**	**core**
MT1C02	**Linear Algebra**	**4**	**5**	**core**
MT1C03	**Real Analysis-I**	**4**	**5**	**core**
MT1C04	**Number Theory**	**4**	**5**	**core**
MT1C05	**Discrete Mathematics**	**4**	**5**	**core**
MT1V06	**Viva Voce**	**2**		

Semester II

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MT2C07	**Algebra- II**	**4**	**5**	**core**
MT2C08	**Real Analysis-II**	**4**	**5**	**core**
MT2C09	**Topology**	**4**	**5**	**core**
MT2C10	**ODE and Calculus of Variations**	**4**	**5**	**core**
MT2C11	**Operations Research**	**4**	**5**	**core**

Semester III

Course Code	Title of the Course	No. of Credits	Work Load Hrs./ week	Core/ Elective
MT3C12	**Multivariable Calculus and Geometry**	**4**	**5**	**core**
MT3C13	**Complex Analysis**	**4**	**5**	**core**
MT3C14	**Functional Analysis**	**4**	**5**	**core**
MT3C15	**PDE and Integral Equations**	**4**	**5**	**core**
	Project		**5**	**core**

MT3V16	**Viva Voce**	**2**		

Semester IV

Course Code	**Title of the Course**	**No. of Credits**	**Work Load Hrs./week**	**Core/ Elective**
Elective-1		**4**	**5**	**Elective**
Elective-2		**4**	**5**	**Elective**
Elective-3		**4**	**5**	**Elective**
Elective-4		**4**	**5**	**Elective**
MT4C17	**Project**	**4**	**5**	**core**

CREDITS

Accumulated minimum credit required for successful completion of course shall be 80.

LIST OF ELECTIVES

MT4E01 COMMUTATIVE ALGEBRA

MT4E02 ALGEBRAIC NUMBER THEORY

MT4E03 MEASURE AND INTEGRATION

MT4E04 FLUID DYNAMICS

MT4E05 ADVANCED OPERATIONS RESEARCH

MT4E06 PROBABILITY THEORY

MT4E07 COMPUTER ORIENTED NUMERICAL ANALYSIS

MT4E08 ALGEBRAIC TOPOLOGY

MT4E09 CRYPTOGRAPHY

MT4E10 ADVANCED COMPLEX ANALYSIS

MT4E11 ADVANCED FUNCTIONAL ANALYSIS

MT4E12 DIFFERENTIAL GEOMETRY

MT4E13 REPRESENTATION THEORY

MT4E14 WAVELET THEORY

MT4E15 GRAPH THEORY

DETAILED SYLLABI

SEMESTER - I

MT1C01 ALGEBRA - I

No. of Credits: 4

No. Of hours of Lectures/week: 5

Text: FRALEIGH, J.B, A FIRST COURSE IN ABSTRACT ALGEBRA. (7th edn.) Narosa (1999)

Module - I

Plane Isometries, Direct products & finitely generated Abelian Groups, Factor Groups, Factor-Group Computations and Simple Groups, Group action on a set, Applications of G-set to counting.

[Sections 12, 11, 4, 14, 15, 16, 17]

Module - II

Isomorphism theorems, Series of groups, (Omit Butterfly Lemma and proof of the Schreier Theorem), Sylow theorems, Applications of the Sylow theory, Free Groups (Omit Another look at free abelian groups).

[Sectipons 34, 35, 36, 37, 39]

Module- III

Group Presentations, Rings of polynomials, Factorization of polynomials over a field, Non Commutative examples, Homomorphism and factor rings.

[40, 22, 23, 24, 26]

REFERENCES

1. I.N. Herstein, Topics in Algebra, Wiley Eastern (Reprint)

2. N.H. McCoy and R.Thomas, Algebra, Allyn & Bacon Inc. (1977).

3. J. Rotman, The theory of groups, Allyn & Bacon Inc. (1973)

4. Hall,Marshall, The theory of groups, Chelsea Pub. Co. NY. (1976)

5. Clark, Allan, Elements of Abstract Algebra, Dover Publications (1984)

6. L.W. Shapiro, Introduction to Abstract Algebra, McGraw Hill Book Co. NY (1975)

7. N.Jacobson, Basic Algebra, vol. I, Hindustan Publishing Corporation, Reprint (1991)

8. T.W. Hungerford, Algebra, Springer Verlag GTM 73 (1987) 4th Printing.

9. D.M. Burton, A First Course in Rings and Ideals, Addison Wesley 1970

10. Mac Lane & Brikhoff, Algebra, Macmillian

11. JosephA.Gallian, Contemporary Abstract Algebra (4thEdn), Narosa 1999

MT1C02 LINEAR ALGEBRA

No of Credits : 4

No. of hours of Lectures/week : 5

Text: HOFFMAN K and KUNZE R., LINEAR ALGEBRA, (2nd Edn.), Prentice- Hall of India, 1991.

Module - I

Vector Spaces & Linear Transformations

[Chapter 2 Sections 2.1 - 2.4; Chapter 3 Sections 3.1 to 3.3 from the text]

Module - II

Linear Transformations (continued) and Elementary Canonical Forms

[Chapter 3 Sections 3.4 - 3.7; Chapter 6 Sections 6.1 to 6.4 from the text]

Module- III

Elementary Canonical Forms (continued), Inner Product Spaces

[Chapter 6. Sections 6.6 & 6.7; Chapter 8 Sections 8.1 & 8.2 from the text]

REFERENCES

1. P.R. Halmos, Finite Dimensional Vector spaces, Narosa Pub House, New Delhi (1980)
2. S. Lang, Linear Algebra, Addison Wesley Pub.Co.
3. I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd Reprint
4. S. Mac Lane and G. Bikhrkhoff, Algebra Macmillan Pub Co NY
5. G.D. Mostow and J.H. Sampson , Linear Algebra, McGraw-Hill Book Co NY (1969)
6. T.W. Hungerford, Algebra, Springer Verlag GTM No 73 (1974)
7. S. Kumaresan, Linear Algebra-A Geometric Approach, Prentice Hall of India (2000)
8. J. B. Fraleigh& R.H. Beauregard, Linear Algebra, Addison Wesley

MT1C03 REAL ANALYSIS – I

No. of Credits : 4
No.of hours of Lectures / week : 5
TEXT: RUDIN, W., PRINCIPLES OF MATHEMATICAL ANALYSIS, (3rd Edn.) Mc. Graw-Hill, 1986.

Module - I

Basic Topololgy – 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.

[Chapter 2 & Chapter 4]

Module – II

Differentiation – The derivative of a 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, Integration and Differentiation.
[Chapters 5 & Chapter 6 up to and including 6.22]

Module – III

The Riemann – Stieltjes Integral (Continued) - Integration of Vector vector-valued Functions, Rectifiable curves.
Sequences and Series of Functions - Discussion of Main problem, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and Differentiation. Equicontinuous Families of Functions, The Stone – Weierstrass Theorem.
[Chapters 6 (from 6.23 to 6.27) & Chapter 7 (upto and including 7.27 only)]

REFERENCES

1. a) R.G. Bartle : Element of Real Analysis, Wiley International Edn (Second Edn) (1976)

   b) R.G. Bartle and D.R. Sherbert : Introduction to Real Analysis, John Wiley Bros (1982)

2. L.M. Graves : The theory of functions of a real variable, Tata McGraw-Hill Book Co (1978)

3. M.H. Protter & C.B. Moray : A first course in Real Analysis, Springer Verlag UTM (1977)

4. S.C. Saxena and SM Shah : Introduction to Real Variable Theory, Intext Educational Publishers San Francisco (1972).
5. I.K.Rana : An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. Hewitt and Stromberg K : Real and Abstract Analysis, Springer Verlag GTM 25 (1975) Reprint
7. S.R. Ghorpade & B.V. Limaye : A course in Calculus and Real Analysis, Springer 2006.

8. Terence Tao : Analysis I &II, Hindustan Book agency.

MT1C04 NUMBER THEORY

No. of Credits 4
No.of hours of Lectures / week : 5

TEXT :
1. APOSTOL, T.M.,: INTRODUCTION TO ANALYTIC NUMBER THEORY, Narosa Publishing House, New Delhi, 1990.
2. KOBLITZ , NEAL:A COURSE IN NUMBER THEROY AND CRYPTOGRAPHY, SpringerVerlag, NewYork, 1987.

Module – I

Arithmetical functions and Dirichlet multiplication; Averages of arithmetical functions [Chapter 2: sections 2.1 to 2.14, 2.18, 2.19; Chapter 3: sections 3.1 to 3.4, 3.9 to 3.12 of Text 1]

Module - II
Some elementary theorems on the distribution of prime numbers [Chapter

4: Sections 4.1 to 4.10 of Text 1]

Module - III

Quadratic residues and quadratic reciprocity law [Chapter 9: sections 9.1 to 9.8 of Text 1]
Cryptography, Public key [Chapters 3 ; Chapter 4 sections 1and 2 of Text 2.]

REFERENCES

[1] W. W Adams & : Introduction to Number Theory L. J. Goldstein Printice Hall Inc.,Engelwoods, (1976)

[2] Tom M. Apostol : Introduction to Analytic Number Theory Springer Inter-national Edn.(4th Reprint) Narosa Pub House,Delhi, (1993)

[3] A.N. Stewart & D.O. Tall : Algebraic Number Theory (2nd Edn.), Chapman & Hall, London,(1985)

[4] P. Samuel : Theory of Algebraic Numbers Hermann Paris Houghton Mifflin (1975)

[5] W.J. Le Veque : Topics in Number Theory ,vols I & II Addison Wesley Pub.Co. Readings Mass (1961)

[6] A Hurwitz & N.Kritiko : Lectures on Number Theory Springer Verlag ,Universitext (1986)

[7] H. Davenport : The higher arithmetic Cambridge Univ.Press, Sixth Edn. (1992)

[8] Kenneth H Rosen : Elementary Number Theory and its applications Addison Wesley Pub Co., 3rd Edn., (1993)

[9] G.H. Hardy & E M Wright : Introduction to the theory of numbers Oxford International Edn (1985)

[10] D.P. Parent : Exercises in Number Theroy Springer Vertlag, (Problem Books in Math) 1984

[11] Don Redmond : Number Theory Monographs & Texts in Mathematics No:220 Marcel Dekker Inc (1994).

[12] Thomas Koshy : Elementary Number Theory with Applications Harcourt / Academic Press 2002

[13] Douglas R Stinson : Cryptography- Theory and Practice (2nd edn.) Chapman & Hall / CRC (214. Simon Sing : The Code Book The Fourth Estate London (1999)

[14] Song Y. Yan : Number Theroy for Computing (2nd Edition) Springer Verlag 2002

[15] Oystein Ore : Number Theory and its History Mc Graw Hill Book Company 1948

[16] Paulo Ribenboim : The little book of Big Primes Springer-Verlag (NewYork 1991)

[17] Albrecht Beautelspacher : Cryptology Mathematical Association of America (Incorporated),1994

MT1C05 DISCRETE MATHEMATICS

No. of Credits 4
No.of hours of Lectures / week : 5

TEXTS:

1. **K.D.JOSHI**, FOUNDATIONS OF DISCRETE MATHEMATICS, NewAge International (P) Ltd. New Delhi 1989
2. **R. BALAKRISHNAN & K. RANGANATHAN** , *A TEXT BOOK OF GRAPH THEORY*, Springer verlag.
3. **PETER LINZ**, AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA. (Second Edition) Narosa Publishing House, New Delhi, 1997.

Module - I

Order Relations, Lattices; Boolean Algebra – Definition and Properties, Boolean Functions. [TEXT 1 - Chapter 3 (section.3 (3.1-3.11), chapter 4 (sections 1& 2)]

Module - II

Basic concepts, Subgraphs, Degree of vertices, Paths and connectedness, Automorphism of a simple graph, Operations on graphs, Vertex cuts and Edge cuts, Connectivity and Edge connectivity, Trees- Definition, Characterization and Simple properties, Eulerian graphs, Planar and Non planar graphs, Euler formula and its consequences, K_5 and $K_{3,3}$ are non planar graphs, Dual of a plane graph. [TEXT 2 – Chapter 1 Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, Chapter 3 Sections 3.1, 3.2, Chapter 4 Section 4.1(upto and including 4.1.10), Chapter 6 Section 6.1(upto and including 6.1.2), Chapter 8 Sections 8.1(upto and including 8.1.7), 8.2(upto and including 8.2.7), 8.3, 8.4.]

Module - III

Automata and Formal Languages: Introduction to the theory of Computation, Finite Automata. [TEXT 3 - Chapter 1 (sections 1.2 & 1.3); Chapter 2 (sections 2.1, 2.2 & 2.3)]

REFERENCES:

[1]. **J.A. Bondy and U.S.R.Murty** : *Graph Theory with applications*. Macmillan

[2]. **F. Harary** : *Graph Theory*, Narosa publishers

[3]. **John Clark and Derek Allan Holton** : *A First look at Graph Theory*, Prentice Hall

[4]. **K.R. Parthasarathy** : *Basic Graph Theory*, Tata-Mc Graw Hill

[5]. **Douglas B**. **West**, Intoduction To Graph Theory (Second Edition) Pearson Education

[6]. **C.L. Liu** : *Elements of Discrete Mathematics* (2^{nd} Edn.) Mc Graw Hill Book Company, 1985.

[7]. **K.H. Rosen** : *Discrete Mathematics and its Applications* (5th Edition) MC Graw Hill 2003.

MT1V06 Viva Voce Examination

Viva voce examination based on the papers

(i) Algebra- I (ii) Linear Algebra (iii) Real Analysis (iv) Number Theory
(v) Discrete Mathematics

of a duration of minimum 5 minutes for each subject.

SEMESTER - II

MT2C07 ALGEBRA – II

No. of Credits: 4

No.of hours of lectures/week: 5

Text: FRALEIGH, J.B: A FIRST COURSE IN ABSTRACT ALGEBRA, (Seventh Edn.)

Narosa (1999)

Module - I

Prime and Maximal Ideals, Introduction to Extension Fields, Algebraic Extensions
(Omit Proof of the Existence of an Algebraic Closure), Geometric Constructions.
[27, 29, 31, 32]

Module - II

Finite Fields, Automorphisms of Fields, The Isomorphism Extension Theorem,
Splitting Fields, Separable Extensions.
[33, 48, 49, 50, 51]

Module - III

Galois Theory, Illustration of Galois Theory, Cyclotomic Extensions, Insolvability of
the Quintic.
[53, 54, 55, 56]

REFERENCES

1. N.H. McCoy and R.Thomas, Algebra, Allyn & Bacon Inc. (1977).

2. J. Rotman, The Theory of Groups Allyn & Bacon, Inc.1973

3. Hall, Marshall, The Theory of Groups, Chelsea Pub.Co. NY 1976

4. Clark, Allan, Elements of Abstract Algebra, Dover Publications (1984)

5. L.W. Shapiro, Introduction to Abstract Algebra, McGraw Hill Book Co. NY (1975)

6. C. Musili, Introduction to Rings and Modules, Narosa Publishing House, New Delhi1922

7. N. Jacobson, Basic Algebra , Vol. I., Hindustan Publishing Corporation, Reprint (1991)

8. P.B. Bhattacharya and S.K. Jain, First Course in Rings, Fields and Vector Spaces, Wiley Eastern Ltd., New Delhi (1976)

9. T.W. Hungerford, Algebra, Springer Verlag GTM 73 (1987) 4th Printing

10. I.N.Herstein, Topics in Algebra. New York, Blaisdell. 1964

11. F Lorenz, Algebra: Volume I: Fields and Galois Theory, Univesitext, Springer

12. P. Morandi, Fields and Galois Theory, Graduate Text in Mathematics, Springer

MT2C08 REAL ANALYSIS – II

No. of Credits : 4
No.of hours of Lectures / week : 5

Text : G. de Barra, Measure Theory and Integration, New Age International (P) Ltd. Publishers, New Delhi, 2006.

Module - I

Lebesgue outer measure, measurable sets, regularity, measurable functions, Borel and Lebesgue measurability,Integration of non-negative functions, the general integral, integration of series Reimann and Lebesgue integrals
Chapters 2 & 3 : Sections: 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3, 3.4

Module - II

Differentiation, continuous non-differentiable functions, functions of bounded variation, Lebesgue's differentiation theorem, differentiation and integration, Lebegues set, Measures and outer measures, extension of a measure, uniqueness of the extension, completion of a measure, measure spaces, integration with respect to a measure Chapters 4 & 5 : Sections: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6

Module - III

Signed measures and the Hahn decomposition, Jordan decompositon, Radon–Nikodym theorem, some applications of Radon Nikodon Theorem, bounded linear functionals on Lp, Lebesgue stieltjes measure(omit proof of Theorem 4 and example 2), absolutely continuous functions, integration by parts, change of variable, Riesz Representation theorem for C(I).
Chapter 8& 9 Sections: 8.1, 8.2 8.3, 8.4, 8.5, 9.1, 9.3, 9.4, 9.5, 9.6

REFERENCES

[1] K. B. Athreya and S. N. Lahiri, Measure Theory, Hindustan Book Agency, New Delhi, 2006.

[2] R. G. Bartle, The Element of Integration, John Wiley, 1964.

[3] S. K. Berberian, Measure and Integration, The McMillan Company, NewYork, 1965.

[4] P. R. Halmos, Measure Theory, Springer verlag.

[5] H. L. Royden, Real Analysis, Prentice Hall India, 1988 (3rd edition).

[6] W. Rudin, Real and Complex Analysis, Tata McGraw Hill, New Delhi, 2006.

[7] I. K. Rana, An Introduction to Measure and Integration, Narosa Publishing company, New York,

MT2C09 TOPOLOGY

No. of Credits : 4
No.of hours of Lectures / week : 5
TEXT: JOSHI, K.D., INTRODUCTION TO GENERAL TOPOLOGY, (Revised Edition) Wiley Eastern Ltd., New Delhi, 1984

Module - I

A Quick Revision of Chapter 1,2 and 3. Topological Spaces, Basic Concepts
[Chapter 4 and Chapter 5 Sections 1, Section 2 (excluding 2.11 and 2.12) and Section 3 only]

<u>Module - II</u>

Making Functions Continuous, Quotient Spaces, Spaces with Special Properties
[Chapter 5 Section 4 and Chapter 6]

<u>Module - III</u>

Separation Axioms: Hierarchy of Separation Axioms, Compactness and Separation Axioms, The Urysohn Characterization of Normality, Tietze Characterisation of Normality.
[Chapter 7: Sections 1 to 3 and Section 4 (up to and including 4.6)]

REFERENCES

1. J .Dugundji : Topology, Prentice Hall of India (1975)
2. S.Willard : General Topology, Addison Wesley Pub Co., Reading Mass (1976)
3. G.F. Simmons : Introduction to Topology and Modern Analysis, McGraw-Hill International Student Edn. (1963)
4. M. Gemignani : Elementary Topology, Addison Wesley Pub Co Reading Mass (1971)
5. M.G. Murdeshwar : General Topology (2nd Edn), Wiley Eastern Ltd (1990)
6. M.A. Armstrong : Basic Topology, Springer Verlag, New York 1983
7. J. R. Munkres : Topology- a First Course, PHI
8. Fred H. Croom : Principles of Topology, Cengage Learning Asia

<u>MT2C10 ODE AND CALCULUS OF VARIATIONS</u>

No. of Credits : 4.
No.of hours of Lectures / week : 5

TEXT: SIMMONS, G.F, DIFFERENTIAL EQUATIONS WITH APPLICATIONS AND HISTORICAL NOTES, TMH Edition, New Delhi, 1974.

<u>Module – I</u>

Power Series Solutions and Special functions; Some Special Functions of Mathematical Physics.
[Chapter 5: Sections 26, 27, 28, 29, 30, 31 ; Chapter 6: Sections 32, 33]

<u>Module – II</u>

Some special functions of Mathematical Physics (continued), Systems of First Order Equations; Non linear Equations
[Chapter 6 : Sections 34, 35 : Chapter 7 :Sections 37, 38, Chapter 8 : Sections 40, 41, 42, 43, 44]

<u>Module – III</u>

Oscillation Theory of Boundary Value Problems, The Existence and Uniqueness of Solutions, The Calculus of Variations.
[Chapter 4 : Sections 22, 23 & Appendix A. (Omit Section 24) ; Chapter 11 : Sections 55, 56,57: Chapter 9 : Sections 47, 48, 49]

REFERENCES

1. G. Birkhoff & G.C. Rota : Ordinary Differential Equations, Edn. Wiley & Sons 3rd Edn (1978)
2. E.A. Coddington : An Introduction to Ordinary Differential Equtions Printice Hall of India, New Delhi (1974)
3. P. Hartman : Ordinary Differential Equations, John Wiley & Sons (1964)
4. L.S. Pontriyagin : A course in ordinary Differential Equations, Hindustan Pub. Corporation,Delhi (1967)
5. Courant R and Hilbert D : Methods of Mathematical Physics , vol I, Wiley Eastern Reprint (1975)
6. W.E. Boyce & R.C. Deprima : Elementary Differential Equations and boundary value problems John Wiley & Sons NY 2nd Edn (1969)
7. A. Chakrabarti : Elements of ordinary Differential Equations and special functions, Wiley Eastern Ltd New Delhi (1990)
8. Ian Sneddon : Elements of Partial Differential Equations, McGraw-Hill International Edn., (1957)

MT2C11 OPERATIONS RESEARCH

No. of Credits: 4

No. of Lectures/Week: 5

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd. Edn.), New Age International(P) Ltd. Publishers.

(Pre requisites : A basic course in calculus and Linear Algebra)

Module – I
Convex Functions; Linear Programming [Chapter 2 : Sections 11 to 12 ; Chapter 3 : Sections 1 to 15, 17 from the text]

Module – II
Linear Programming (contd.); Transportation Problem [Chapter 3 : Sections 18 to 20, 22; Chapter 4 Sections 1 to 11, 13 from the text]

Module – III
Integer Programming; Sensitivity Analysis [Chapter 6 : Sections 1 to 9; Chapter 7 Sections 1 to 10 from the text]
Flow and Potential in Networks; Theory of Games [Chapter 5 : Sections 1 to 4, 6 7; Chapter 12 : all Sections]

REFERENCES

[1] G. Hadley., Linear Programming, Addison-Wesley Pub Co Reading, Mass, 1975.

[2] G. Hadley., Non-linear and Dynamic Programming, Wiley Eastern Pub Co.Reading, Mass, 1964.

[3] S.S.Rao., Optimization - Theory and applications(2nd Edn.), Wiley Eastern(P) Ltd., New Delhi.

[4] Russel L Ackoff; MauriceW.Sasioni., Fundamentals of Operations Research, Wiley Eastern Ltd. New Delhi, 1991.

[5] Charles S. Beightler; D.T.Philiphs; D.J. Wilde., Foundations of optimization(2nd Edn.), Prentice Hall of India, Delhi, 1979.

[6] Hamdy A.Taha, Operations Research: An Introduction(4th Edn.), Macmillan Pub Co. Delhi, 1989.

SEMESTER – III

MT3C12 MULTIVARIABLE CALCULUS AND GEOMETRY

No. of Credits: 4

No. of Lectures/Week: 5

Texts

1 **RUDIN W, PRINCIPLES OF MATHEMATICAL ANALYSIS, (3rd Edn.) Mc. Graw-Hill, 1986.**

2. ANDREW PRESSLEY, ELEMENTARY DIFFERENTIAL GEOMETRY, (2nd Edn) Springer-Verlag 2010.

Module - I

Functions of Several Variables – Linear Transformations, Differentiation, The Contraction Principle, The Inverse Function Theorem, the Implicit Function Theorem. [Chapter 9 – Sections 1-29, 33-37 from Text – 1]

Module - II

What is a curve? Arc-length, Reparametrization, Closed curves 1.5 Level curves versus parametrized curves. Curvature, Plane curves, Space curves

What is a surface, Smooth surfaces, Smooth maps, Tangents and derivatives, Normals and orientability.

[Chapter 1 – Sections 1- 5, Chapter 2 – Sections 1 – 3, Chapter 4 – Sections 1 – 5 from Text - 2]

Module - III

Applications of the inverse function theorem, Lengths of curves on surfaces, The second fundamental form, The Gauss and Weingarten maps, Normal and geodesic curvatures. Gaussian and mean curvatures, Principal curvatures of a surface. [Chapter 5 – Section 6, Chapter 6 – Sections 1,

Chapter 7 – Sections 1 – 3, Chapter 8 – Sections 1 – 2 from Text - 2]

REFERENCES

1. J.R. Munkres, Analysis on Manifolds, Westview Press, 1997
2. Michael Spivak, Calculus on Manifolds, Westview Press, 1971.
3. C.C. Pugh, Real Mathematical Analysis, Springer, 2010.
4. M. Spivak, A Comprehensive Introduction to Differential Geometry, Vol. 1,
Publish or Perish, Boston, 1970.

5. W Klingenberg , A course in Differential Geometry

6. M.P. do Carmo, Differential Geometry of Curves and Surfaces

MT3C13 COMPLEX ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : LARS V. AHLFORS : Complex Analysis, 3rd edn. Mc Graw Hill (1979)
Module - I

Conformality, Linear Transformations, Fundamental Theorems, Cauchy's Integral Formula.

(**Chap. 3,** Sections : 2.1,2.2, 2.3, 3.1, 3.2 & 3.3 **Chap. 4,** Sections : 1.1 to 2.3)

Module - II

Local Properties of Analytical Functions, The General Form of Cauchy's Theorem, The Calculus of Residues, Harmonic Functions. (**Chap. 4,** Sections : 3.1 to 6.4)

Module - III

Power Series Expansions, Simply Periodic Functions, Doubly Periodic Functions, The Weierstrass Theory. (**Chap. 5,** Sections : 1.1 to 1.3 **Chap. 7,** Sections : 1.1 to 3.3)

REFERENCES :

1. Cartan, H. : Elementary Theory of Analytic Functions of one or Several Variables, Addison - Wesley Pub. Co. (1973)

2. Conway, J.B. : Functions of One Complex Variable, Narosa Pub. Co., New Delhi. (1973)

3. Moore T.O. &Hadlock E.H. : Complex Analysis, Series in Pure Mathematics - Vol. 9. World Scientific . (1991)

4. Pennisi, L. : Elements of Complex Variables, Holf, Rinehart & Winston, 2nd Edn. (1976)

5. Rudin, W. : Real and Complex Analysis, 3rd Edn. McGraw - Hill International Edn. (1987)

6. Silverman, H. : Compex Variables, Houghton Mifflin Co. Boston (1975)

7. Remmert, R. : Theory of Complex Functions, UTM, Springer- Verlag, NY, (1991)

MT3C14 FUNCTIONAL ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : LIMAYE B.V, FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

Module - I

Metric spaces and Continuous Functions (section 3, 3.1 to 3.4, 3.11 to 3.13(without proof)), Lp spaces , Fourier series and Integrals (section 4.5 to4.7, 4.8 to 4.11(without proof)), Normed spaces (section 5) Continuity of linear maps (section 6).

Module – II

Hahn-Banach Theorems (section 7, omit Banach limits) Banach spaces (section 8) Uniform Boundedness Principle (section 9, omit Quadrature Formulae and Matrix Transformations and Summability Methods).

Module - III

Closed Graph and Open Mapping Theorems (section 10), Bounded Inverse Theorem(section 11.1), Inner product spaces, Orthonormal sets (Sections 21 and 22).

REFERENCES :

1. R. Bhatia, Notes on Functional Analysis TRIM series, Hindustan Book Agency
2. Kesavan S, Functional Analysis, TRIM series, Hindustan Book Agency
3. S David Promislow, A First Course in Functional Analysis, Wiley Interscience, John wiley & Sons, INC., (2008)
4. Sunder V.S, Functional Analysis, TRIM series, Hindustan Book Agency
5. George Bachman & Lawrence Narici, Functional Analysis , Academic Press, NY (1970)
6. Kolmogorov and Fomin S.V, Elements of the Theory of Functions and Functional Analysis. English Translation, Graylock Press, Rochaster NY (1972)
7. W. Dunford and J. Schwartz, Linear Operators Part 1, General Theory, John Wiley & Sons (1958)
8. E.Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons 1978)
9. F. Riesz and B. Nagy, Functional Analysis, Frederick Unger NY (1955)
10. J.B.Conway, Functional Analysis, Narosa Pub House New Delhi (1978)
11. Walter Rudin, Functional Analysis, TMH edition (1978)
12. Walter Rudin, Introduction to Real and Complex Analysis, TMH edition (1975)
13. J.Dieudonne, Foundations of Modern Analysis, Academic Press (1969)
14. Yuli Eidelman,Vitali Milman and Antonis Tsolomitis, Functional analysis An Introduction,

Graduate Studies in Mathematics, Vol. 66 American Mathematical Society 2004.

MT3C15 PDE AND INTEGRAL EQUATIONS

No. of Credits : 4
No.of hours of Lectures / week : 5

TEXTS :
1. AMARNATH, M., : PARTIAL DIFFERENTIAL EQUATIONS, Narosa , New Delhi (1997)

2. HILDEBRAND, F.B.: METHODS OF APPLIED MATHEMATICS, (2nd Edn.) Prentice-Hall of India, New Delhi, 1972.

Module – I

First Order PDE .
[Sections 1.1 – 1.11. from the Text 1], Omit the Proof of Theorem 1.11.1

Module – II

Second Order PDE
[Sections 2.1 – 2.5. from the Text 1]

Module – III

Integral Equations.
[Sections 3.1 – 3.3, 3.6 – 3.11 from the Text 2]

REFERENCES

1. G. Birkhoff & G.C. Rota : Ordinary Differential Equations, Edn. Wiley & Sons 3rd Edn (1978)

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

3. P. Hartman : Ordinary Differential Equations, John Wiley & Sons (1964)

4. L.S. Pontriyagin : A Course in Ordinary Differential Equations, Hindustan Pub. Corporation, Delhi (1967)

5. F. John : Partial Differential Equations, Narosa Pub. House New Delhi (1986)

6. Phoolan Prasad & : Partial Differential Equations, Renuka Ravindran Wiley Eastern Ltd New Delhi (1985)

7. R. Courant and D.Hilbert : Methods of Mathematical Physics , Vol I, Wiley Eastern Reprint (1975)

8. W.E. Boyce & R.C. Deprima : Elementary Differential Equations, and Boundary Value Problems John Wiley & Sons, NY, 9th Edition

9. A. Chakrabarti : Elements of Ordinary Differential, Equations and Special Functions, Wiley Eastern Ltd New Delhi (1990)

10. Ian Sneddon : Elements of Partial Differential Equations, McGraw-Hill International Edn., (1957

MT3V16 Viva Voce Examination

Viva voce examination based on the papers

(i) Multivariable Calculus and Geometry (ii) Complex Analysis (iii) Functional Analysis
(iv) PDE and Integral Equations

of a duration of minimum 5 minutes for each subject.

ELECTIVES

MT4E01 COMMUTATIVE ALGEBRA

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : ATIYAH,M.F & MACDONALD, I.G, INTRODUCTION TO COMMUTATIVE ALGEBRA, Addison Wesley, N.Y, (1969).

Module – I

Rings and Ideals, Modules
[Chapters I and II from the text]

Module – II

Rings and Modules of Fractions, Primary Decomposition
[Chapters III & IV from the text]

Module – III

Integral Dependence and Valuation, Chain conditions, Noetherian rings, Artinian rings
[Chapters V, VI, VII & VIII from the text]

REFERENCES

1. N. Bourbaki : Commutative Algebra, Paris - Hermann, 1961

2. D. Burton : A First Course in Rings and Ideals, Addison - Wesley , 1970.

3. N.S. Gopalakrishnan : Commutative Algebra, Oxonian Press, 1984.

4. T.W. Hungerford : Algebra, Springer - Verlag, 1974

5. D.G. Northcott : Ideal Theory, Cambridge University Press, 1953

6. O. Zariski & P. Samuel : Commutative Algebra, Vols. I & II, Van Nostrand, Princeton, 1960

MT4E02 ALGEBRAIC NUMBER THEORY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : I. N. STEWART & D.O. TALL, ALGEBRAIC NUMBER THEORY, (2nd Edn.), Chapman & Hall, (1987)

Module – I

Symmetric polynomials, Modules, Free abelian groups, Algebraic Numbers, Conjugates and Discriminants, Algebraic Integers, Integral Bases, Norms and Traces, Rings of Integers, Quadratic Fields, Cyclotomic Fields.
[Chapter1, Sections 1.4 to 1.6; Chapter 2, Sections 2.1 to 2.6; Chapter 3, Sections 3.1 and 3.2 from the text]

Module – II

Historical background, Trivial Factorizations, Factorization into Irreducibles, Examples of Nonunique Factorization into Irreducibles, Prime Factorization, Euclidean Domains, Eucidean Quadratic fields
Ideals – Historical background, Prime Factorization of Ideals, The norm of an ideal
[Chapter 4, Sections 4.1 to 4.7, Chapter 5, Sections 5.1 to 5.3.]

Module – III

Lattices, The Quotient Torus, Minkowski theorem, The Space Lst, The Class-Group An Existence Theorem, Finiteness of the Class-Group, Factorization of a Rational Prime, Fermat's Last Theorem – Some history, Elementary Considerations, Kummer's Lemma, Kummer's Theorem.
[Chapter 6, Chapter 7, Section 7.1 Chapter 8, Chapter 9, Sections 9.1 to 9.3, Chapter 10. Section 10.1, Chapter 11: 11.1 to 11.4.]

REFERENCES

1. P. Samuel : Theory of Algebraic Numbers, Herman Paris Houghton Mifflin, NY, (1975)
2. S. Lang : Algebraic Number Theory, Addison Wesley Pub Co., Reading, Mass, (1970)
3. D. Marcus : Number Fields, Universitext, Springer Verlag, NY, (1976)
4. T.I.FR. Pamphlet No: 4 : Algebraic Number Theory (Bombay, 1966)
5. Harvey Cohn : Advanced Number Theory, Dover Publications Inc., NY, (1980)
6. Andre Weil : Basic Number Theory, (3rd Edn.), Springer Verlag, NY, (1974)
7. G.H. Hardy and E.M. Wright : An Introduction to the Theory of Numbers, Oxford University Press.
8. Z.I. Borevich & I.R.Shafarevich : Number Theory, Academic Press, NY 1966.
9. Esmonde & Ram Murthy : Problems in Algebraic Number Theory, Springer Verlag 2000.

MT4E03 MEASURE AND INTEGRATION

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT : WALTER RUDIN : Real and Complex Analysis ,

3rd Edition, Mc Graw Hill International Edn. New Delhi (1987)

Module – I

The concept of measurability, Simple functions, Elementary properties of measures, Arithmetic in [0,infinity], Integration of Positive Functions, Integration of Complex Functions, The Role Played by Sets of Measure zero, Topological Preliminaries, The Riesz Representation Theorem.

(**Chap. 1,** Sections : 1.2 to 1.41 **Chap. 2,** Sections : 2.3 to 2.14)

Module – II

Regularity Properties of Borel Measures, Lebesgue Measure, Continuity Properties of Measurable Functions. Total Variation, Absolute Continuity, Consequences of Radon - Nikodym Theorem.

(**Chap. 2,** Sections : 2.15 to 2.25 **Chap. 6**, Sections : 6.1 to 6.14)

Module – III

Bounded Linear Functionals on L^P, The Riesz Representation Theorem, Measurability on Cartesian Products, Product Measures, The Fubini Theorem, Completion of Product Measures.

(**Chap. 6,** Sections : 6.15 to 6.19 **, Chap. 8,** Sections : 8.1 to 8.11)

REFERENCES :

1. P.R. Halmos : Measure Theory, Narosa Pub. House New Delhi (1981) Second Reprint

2. H.L. Roydon : Real Analysis, Macmillan International Edition (1988) Third Edition

3. E.Hewitt & K. Stromberg : Real and Abstract Analysis, Narosa Pub. House New Delhi (1978)

4. A.E.Taylor. : General Theory of Functions and Integration, Blaidsell Publishing Co NY (1965)

5. G.De Barra : Measure Theory and Integration, Wiley Eastern Ltd. Bangalore (1981)

MT4E04 FLUID DYNAMICS

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : L.M. MILNE-THOMSON, THEORETICAL HYDRODYNAMICS, (Fifth Edition) Mac Millan Press, London, 1979.

Module – I

EQUATIONS OF MOTION : Differentiation w.r.t. the time, The equation of continuity Boundary condition (Kinematical and Physical), Rate of change of linear momentum, The equation of motion of an invicid fluid, Conservative forces, Steady motion, The energy equation, Rate of change of circulation, Vortex motion, Permanence of vorticity, Pressure equation, Connectivity, Acyclic and cyclic irrotational motion, Kinetic energy of liquid, Kelvin's minimum energy theorem.
TWO-DIMENSIONAL MOTION : Motion in two-dimensions, Intrinsic expression for the vorticity; The rate of change of vorticity; Intrinsic equations of steady motion; Stream function; Velocity derived from the stream-function; Rankine's method; The stream function of a uniform stream; Vector expression for velocity and vorticity; Equation satisfied by stream function; The pressure equation; Stagnation points; The velocity potential of a liquid; The equation satisfied by the velocity potential.
[Chapter III: Sections 3.10, 3.20, 3.30, 3.31, 3.40, 3.41, 3.43, 3.45, 3.50, 3.51, 3.52, 3.53, 3.60, 3.70, 3.71, 3.72, 3.73. Chapter IV : All Sections.]

Module - II

STREAMING MOTIONS : Complex potential; The complex velocity stagnation points, The speed, The equations of the streamlines, The circle theorem, Streaming motion past a circular cylinder; The dividing streamline, The pressure distribution on the cylinder, Cavitation, Rigid boundaries and the circle theorem, The Joukowski transformation, Theorem of Blasius.
AEROFOILS: Circulation about a circular cylinder, The circulation between concentric cylinders, Streaming and circulation for a circular cylinder, The aerofoil, Further investigations of the Joukowski transformation Geometrical construction for the transformation, The theorem of Kutta and Joukowski.
[Chaper VI : Sections 6.0, 6.01, 6.02, 6.03, 6.05, 6.21, 6.22, 6.23, 6.24, 6.25, 6.30, 6.41. Chapter VII: Sections 7.10, 7.11, 7.12, 7.20, 7.30, 7.31, 7.45.]

Module - III

SOURCES AND SINKS: Two dimensional sources, The complex potential for a simple source, Combination of sources and streams, Source and sink of equal strengths Doublet, Source and equal sink in a stream, The method of images, Effect on a wall of a source parallel to the wall, General method for images in a plane, Image of a doublet in a plane, Sources in conformal transformation Source in an angle between two walls, Source outside a circular cylinder, The force exerted on a circular cylinder by a source.
STKOKES' STREAM FUNCTION: Axisymmetrical motions Stokes' stream function, Simple source, Uniform stream, Source in a uniform stream, Finite line source, Airship forms, Source and equal sink - Doublet; Rankin's solids.
[Chapter VIII. Sections 8.10, 8.12, 8.20, 8.22, 8.23, 8.30, 8.40, 8.41, 8.42, 8.43, 8.50, 8.51, 8.60, 8.61, 8.62. Chapter XVI. Sections 16.0, 16.1, 16.20, 16.22, 16.23, 16.24, 16.25, 16.26, 16.27]

REFERENCES

1. Von Mises and K.O. Friedrichs : Fluid Dynamics, Springer International Edition. Reprint, (1988)

2. James EA John : Introduction to Fluid Mechanics (2nd Edn.), William L Haberman Prentice Hall of India ,Delhi,(1983). Reprint.

3. Chorlten : Text Book of Fluid Dynamics, CBS Publishers, Delhi 1985

4. A. R. Patterson : A First Course in Fluid Dynamics, Cambridge University Press 1987.

MT4E05 ADVANCED OPERATIONS RESEARCH

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONS RESEARCH AND SYSTEMS ANALYSIS(3rd.Edn.), New Age International(P) Ltd. Publishers.

(Pre requisites : A basic course in calculus and Linear Algebra)

Module – I

Kuhn Tucker theory and Nonlinear programming [Chapter 8 : Sections 1 to 7]

Module – II

Geometric Programming [Chapter 9 : Sections 1 to 6]

Module – III

Dynamic Programming [Chapter 10 : Sections 1 to 10]

REFERENCES

[1] G. Hadley., Linear Programming, Addison-Wesley Pub Co Reading, Mass, 1975.

[2] G. Hadley., Non-linear and Dynamic Programming, Wiley Eastern Pub Co.Reading, Mass, 1964.

[3] S.S.Rao., Optimization - Theory and applications(2nd Edn.), Wiley Eastern(P) Ltd., New Delhi.

[4] Russel L Ackoff; MauriceW.Sasioni., Fundamentals of Operations Research, Wiley Eastern Ltd. New Delhi, 1991.

[5] Charles S. Beightler; D.T.Philiphs; D.J. Wilde., Foundations of optimization(2nd Edn.), Prentice Hall of India, Delhi, 1979.

[6] Hamdy A.Taha, Operations Research: An Introduction(4th Edn.), Macmillan Pub Co. Delhi, 1989.

MT4E06 PROBABILITY THEORY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT : B.R. BHAT, MODERN PROBABILITY THEORY, (2nd Edn.) Wiley Eastern Limited, Delhi (1988)

Module – I

SETS AND CLASSES OF EVENTS : The event; (A quick review of Algebra of sets &

Fields and s - fields); Class of events.
RANDOM VARIABLES: (Review of Functions and inverse functions); Random variables; Limits of random variables.
PROBABILITY SPACE : Definition of probability; Some simple properties; Discrete probability Space; General Probability space; Induced probability space
DISTRIBUTION FUNCTIONS: Distribution function of a random variable; Decomposition of D.F; Distribution functions of vector random variables; Correspondence theorem.
[Chapters 1 to 4 from the text]

Module - II

EXPECTATION AND MOMENTS: Definition of expectation; Properties of expectation; Moments, inequalities.
CONVERGENCE OF RANDOM VARIABLES: Convergence in probability; Convergence almost surely; Convergence in Distribution; Convergence in rth mean; Convergence theorems for expectations; Fubini's theorem.
CHARACTERISTIC FUNCTIONS: Definition and simple properties; Some more properties; Inversion formula; Characteristic functions and moments; Bochner's theorem
CONVERGENCE OF DISTRIBUTION FUNCTIONS : Weak convergence; Convergence of distribution functions and characteristic Functions; Convergence of moments.
[Chapters 5 to 8, from the text]

Module - III

INDEPENDENCE : Definition; Multiplication properties; Zero-one law.
LAWS OF LARGE NUMBERS: Convergence of a series of independent random variables; Kolmogorov Inequalities and A.S. Convergence; Stability of independent R.V's.
CENTRAL LIMIT THEOREM: Introduction; I.I.D. Case; Variable distributions
[Chapters 9, 10, 11 (sections 11.1 to 11.3)]

REFERENCES

1. P. Billingsley : Probability and Measure- John Wiley & Sons NY (1979)

2. K.L. Chung : Elementary Probability Theory with Stochastic Processes, Narosa Pub House, New Delhi (1980)

3. W. Feller : An Introduction to Probability Theory and its Applications, Vols I & II- John Wiley & Sons, NY (1968) and (1971)

4. E. Parzen : Modern Probability Theory and its Applications, Wiley Eastern Limited, New Delhi (1972)

5. H.G. Tucker : A Graduate Course in Probability- Academic Press NY (1967)

MT4E07 COMPUTER ORIENTED NUMERICAL ANALYSIS

No. of Credits : 4
No. of hours of Lectures/week : 5

Programming Language: Python

Texts:

1. **A Byte of Python, Swaroop C H**
2. **Numerical Methods, E Balagurusamy, Tata McGraw-Hill Publishing Company Limited, New Delhi.**

THEORY PART

UNIT I (Text Book 1, Text Book 2)

A quick review of preliminaries of computers, numerical computing, programming languages, Algorithms, flow charts, computer codes based on chapter 1, 2 and 3 of text book 2

Approximations and errors in computing: Significant Digits, Numerical Errors, Absolute and relative errors, convergence of iterative processes and error estimation. (Sections 4.2, 4.4, 4, 7, 4.11 and 4.12 of text book 2)

A quick review of chapters 1, 2 and 3 of Text Book 1

Chapter 4: The Basics: Literal Constants, Numbers, Strings, Variables, Identifier, Data types

Chapter 5: Operators, Operator Precedence, Expressions

Chapter 6: Control flow: If, while, for, break, continue statements

Chapter 7: Functions: Defining a function, function parameters, local variables, default arguments, keywords, return statement, Doc-strings

Chapter 8: Modules: using system modules, import statements, creating modules

Chapter 9: Data Structures: Lists, tuples, sequences.

Chapter 10: Writing a python script

Chapter 12: Files: Input and output using file and pickle module

Chapter 13: Exceptions: Errors, Try-except statement, raising exceptions, try-finally statement

UNIT II (Text Book 2)

Chapter 6: Roots of Nonlinear Equations: Evaluation of Polynomials, Bisection method, Newton-Raphson Method, Complex roots by Bairstow method. (Sections 6.5, 6.6, 6.8 and 6.15)

Chapter 7: Direct Solution of Linear Equations: Solution by elimination, Gauss Elimination method, Gauss Elimination with Pivoting, Triangular Factorisation method (Dolitle Algorithm). (Sections 7.3, 7.4, 7.5 and 7.7)

Chapter 8: Iterative Solution of Linear Equations: Jacobi Iteration method, Gauss-Seidel method. (Sections 8.2 and 8.3)

UNIT III (Text Book 3)

Chapter 9: Curve Fitting-Interpolation: Lagrange Interpolation Polynomial, Newton Interpolation Polynomial, Divided Difference Table, Interpolation with Equidistant points.(Sections 9.4, 9.5, 9.6 and 9.7)

Chapter 11: Numerical Differentiation: Differentiating Continuous functions, Differentiating Tabulated functions. (Sections 11.2 and 11.3)

Chapter 12: Numerical Integration: Trapezoidal Rule, Simpson’s 1/3 rule. (Sections 12.3 and 12.4)

Chapter 13: Numerical Solution of Ordinary Differential Equations: Euler’s Method, Rung-Kutta method (Order 4) (Sections 13.3 and 13.6).

Chapter 14: Eigenvalue problems: Polynomial Method, Power method. (Sections 14.5 and 14.6)

PRACTICAL PART

The following programs in Python have to be done on a computer and a record of algorithm,
Printout of the program and printout of solution as shown by the computer for each program should be maintained. These should be bound together and submitted to the examiners at the time of practical examination.

Sample Programs (Recommended)

GCD of two numbers
To Check an integer prime
Evaluation of Totient Function
Writing of Fibonacci sequence
Listing of prime numbers
Average and maximum of a set of numbers

Programs (Compulsory)

Part A

Lagrange Interpolation
Newton's Interpolation
Bisection Method
Newton-Raphson Method
Numerical Differentiation of continuous function
Numerical Differentiation of tabulated function
Trapezoidal rule of Integration
Simpson's rule of Integration

Part B

Euler's method
Runge – Kutta method of order 4
Gauss elimination with pivoting
Bairstow Method of finding complex root
Runge – Kutta method of order 4
Gauss – Seidal iteration
Eigen value evaluation
Triangular Factorisation

REFERENCES

SD Conte and Carl De Boor : Elementary Numerical Analysis (An algorithmic approach) – 3rd edition, McGraw-Hill, New Delhi
K. Sankara Rao : Numerical Methods for Scientists and Engineers – Prentice Hall of India, New Delhi.
Carl E Froberg : Introduction to Numerical Analysis, Addison Wesley Pub Co, 2nd Edition
Knuth D.E. : The Art of Computer Programming: Fundamental Algorithms(Volume I), Addison Wesley, Narosa Publication, New Delhi.
Python Programming, wikibooks contributors
Programming Python, Mark Lutz,
Python 3 Object Oriented Programming, Dusty Philips, PACKT Open source Publishing
Python Programming Fundamentals, Kent D Lee, Springer
Learning to Program Using Python, Cody Jackson, Kindle Edition
Online reading http://pythonbooks.revolunet.com/

MT4E08 ALGEBRAIC TOPOLOGY

No. of Credits : 4

Number of hours of Lectures/week : 5

TEXT : FRED H. CROOM., BASIC CONCEPTS OF ALGEBRAIC TOPOLOGY, UTM, Springer Verlag ,NY, 1978.

(Pre requisites : Fundamentals of group theory and Topology)

Module – I

Geometric Complexes and Polyhedra: Introduction. Examples, Geometric Complexes and Polyhedra ;Orientation of geometric complexes.
Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups; The structure of homology groups; [Chapter 1 Sections 1.1 to 1.4; Chapter 2 Sections 2.1 to 2.3 from the text]

Module – II

Simplicial Homology Groups (Contd.): The Euler Poincare's Theorem; Pseudomanifolds and the homology groups of Sn . Simplicial Approximation: Introduction ; Simplicial approximation ; Induced homomorphisms on the Homology groups; The Brouwer fixed point theorem and related results [Chapter 2 Sections 2.4,2.5; Chapter 3 Sections 3.1 to 3.4 from the text]

Module – III

The Fundamental Group : Introduction; Homotopic Paths and the Fundamental Group; The Covering Homotopy Property for S1; Examples of Fundamental Groups. [Chapter 4 Sections 4.1 to 4.4 from the text]

REFERENCES

[1] Eilenberg S; Steenrod N., Foundations of Algebraic Topology, Princeton Univ. Press, 1952.

[2] S.T. Hu., Homology Theory, Holden-Day, 1965.

[3] 3. MasseyW.S., Algebraic Topology : An Introduction, Springer Verlag NY, 1977.

[4] 4. C.T.C. Wall., A Geometric Introduction to Topology, Addison-Wesley Pub. Co. Reading Mass, 1972.

MT4E09 CRYPTOGRAPHY

No. of Credits : 4

Number of hours of Lectures/week : 5

Text: **Douglas R. Stinson, *Cryptography Theory and Practice,* Chapman & Hall, 2nd Edition.**

Module - I

Classical Cryptography**:** – Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers. Cryptanalysis of the Affine, Substitution, Vigenere, Hill and LFSR Stream Cipher.

Module - II

Shannon's Theory:- Elementary Probability Theory, Perfect Secrecy, Entropy, Huffman Encodings, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystem.

Module - III

Block Ciphers**:** –Substitution Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis , Data Encryption Standard (DES), Advanced Encryption Standard (AES).

Cryptographic Hash Functions**:** Hash Functions and Data integrity, Security of Hash Functions, iterated hash functions- MD5, SHA 1, Message Authentication Codes, Unconditionally Secure MAC s.

[Chapter 1 : Section 1.1(1.1.1 to 1.1.7), Section 1.2 (1.2.1 to 1.2.5) ; Chapter 2 : Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 ; Chapter 3 : Sections 3.1, 3.2, 3.3(3.3.1 to 3.3.3), Sect.3.4, Sect. 3.5(3.5.1,3.5.2), Sect.3.6(3.6.1, 3.6.2); Chapter 4 : Sections 4.1, 4.2(4.2.1 to 4.2.3), Section 4.3 (4.3.1, 4.3.2), Section 4.4(4.4.1, 4.4.2), Section 4.5 (4.5.1, 4.5.2)]

REFERENCES:

1. **Jeffrey Hoffstein, Jill Pipher, Joseph H. Silverman**, An Introduction to Mathematical Cryptography, Springer International Edition.
2. **H. Deffs & H. Knebl** , *Introduction to Cryptography*, Springer – Verlag, 2002.
3. **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone**, *Handbook of Applied Cryptography*, CRC Press, 1996.
4. **William Stallings**, *Cryptography and Network Security Principles and Practice*, Third Edition, Prentice-hall India, 2003.

MT4E10 ADVANCED COMPLEX ANALYSIS

No. of Credits : 4

No. of Hours of Lectures/week : 5

TEXT - 1 : LIANG – SHIN HAHN BERNARD EPSTEIN : Classical Complex Analysis , Jones And Bartlett Publishers (1996)

TEXT - 2 : JOHN B. CONWAY, Functions of One Complex Variable, 2nd Edn., Springer International Edn. (1973)

Module - I

The Mittag - Leffler Theorem, A Theorem of Weierstrass, Extensions of Theorems of Mittag -Leffler and Weierstrass, Infinite Products, Blaschke Product,The Factorisation of Entire Functions, The Jensen formula. (**Chap. 7,** Sections : 7.1 to 7.7 from *Text 1.*)

Module - II

Entire Functions of Finite Order, Runge Approximation Theorem, The Power Series Method, Natural Boundaries, Multiple Valued Functions. (**Chap. 7,** Sections : 7.8 ,7.9 & **Chap. 8,** Sections 8.1 to 8.3 from *Text 1.*)

Module - III

The Schwarz Symmetry Principle, The Monodromy Theorem, The Space of Continuous Functions, Space of Analytic Functions, Space of Meromorphic Functions, The Riemann Mapping Theorem. (**Chap. 8,** Sections : 8.5, 8.6 from *Text 1.* & **Chap. 7,** Sections : 7.1 to 7.4 from *Text 2.*)

REFERENCES :

1. Cartan H, Elementary Theory of Analytic Functions of one or Several Variables, Addison-Wesley Pub. Co. (1973)

2. Conway J.B, Functions of One Complex Variable, Narosa Pub. Co, New Delhi (1973)

3. Moore T.O. & Hadlock E.H, Complex Analysis, Series in Pure Mathematics - Vol. 9. World Scientific, (1991)

4. Pennisi L, Elements of Complex Variables, Holf, Rinehart & Winston, 2nd Edn. (1976)

5. Rudin W, Real and Complex Analysis, 3rd Edn. Mc Graw - Hill International Edn. (1987)

6. Silverman H, Compex Variables, Houghton Mifflin Co. Boston (1975)

7. Remmert R, Theory of Complex Functions, UTM, Springer- verlag, NY, (1991)

MT4E11 ADVANCED FUNCTIONAL ANALYSIS

No. of Credits : 4

Number of hours of Lectures/week : 5

TEXT : LIMAYE , B.V, FUNCTIONAL ANALYSIS, (2nd Edn.) New Age International Ltd, Publishers, New Delhi, Bangalore (1996)

Module - I

Duals and Transposes (section 13, upto and including 13.8), Duals of L_p [a,b] and C[a,b] (section 14) weak and weak* convergence (section 15, omit 15,5 and 15.6)Reflexivity (section 16, Omit 16.3 and the proof of 16.6),

Module - II

Definition of Compact Linear Map, spectrum of a compact operator(section 18)

Riesz Representation Theorems (section 24,omit24.1).

Module - III

Bounded Operators and Adjoints (section 25), Normal, Unitary and Self Adjoint Operators (section 26, omit Fourier-Plancherel Transform), Spectrum and Numerical Range (section 27), Compact self Adjoint Operators (section 28 , omit 28.7 and 28.8(b)).

References

1.R. Bhatia, Notes on Functional Analysis TRIM series, Hindustan Book Agency

2.KesavanS, Functional Analysis TRIM series, Hindustan Book Agency

3. S David Promislow, A First Course in Functional Analysis Wiley Interscience, John wiley & Sons, INC., (2008)

4. Sunder V.S, Functional Analysis TRIM Series, Hindustan Book Agency

5.GeorgeBachman&LawrenceNarici, Functional Analysis Academic Press, NY (1970)

6. Kolmogorov andFomin S.V, Elements of the Theory of Functions and Functional Analysis. English Translation, Graylock, Press Rochaster NY (1972)

7.W.DunfordandJ.Schwartz, LinearOperatorsPart1,GeneralTheory John Wiley & Sons (1958)

8.E.Kreyszig, Introductory Functional Analysis with Applications John Wiley & Sons (1978)

9.F. Riesz and B. Nagy, Functional Analysis Frederick Unger NY (1955)

10. J.B.Conway, Functional Analysi Narosa Pub House New Delhi (1978)

11. Walter Rudin, Functional Analysis TMH edition (1978)

12. Walter Rudin, Introduction to Real and Complex Analysis TMH edition (1975)

13. J.Dieudonne, Foundations of Modern Analysis Academic Press (1969)

14.YuliEidelman,Vitali Milman and Antonis Tsolomitis, Functional analysis An Introduction, Graduate Studies in Mathematics Vol. 66 American Mathematical Society 2004.

MT4E12 DIFFERENTIAL GEOMETRY

No. of Credits : 4
No. of hours of Lectures/week : 5

TEXT: J.A.THORPE : ELEMENTARY TOPICS IN DIFFERENTIAL GEOMETRY Springer – Verlag, New York.

Module – I

Graphs and Level Set, Vector fields, The Tangent Space, Surfaces, Vector Fields on Surfaces, Orientation. The Gauss Map. [Chapters : 1,2,3,4,5,6 from the text.]

Module – II

Geodesics, Parallel Transport, The Weingarten Map, Curvature of Plane Curves, Arc Length and Line Integrals. [Chapters : 7,8,9,10,11 from the text].

Module – III

Curvature of Surfaces, Parametrized Surfaces, Local Equivalence of Surfaces and Parametrized Surfaces. [Chapters 12,14,15 from the text]

REFERENCES

1. W.L. Burke : Applied Differential Geometry, Cambridge University Press (1985)
2. M. de Carmo : Differential Geometry of Curves and Surfaces, Prentice Hall Inc Englewood Cliffs NJ (1976)
3. V. Grilleman and A. Pollack : Differential Topology, Prentice Hall Inc Englewood Cliffs NJ (1974)
4. B. O'Neil : Elementary Differential Geometry, Academic Press NY (1966)
5. M. Spivak : A Comprehensive Introduction to Differential, Geometry, (Volumes 1 to 5), Publish or Perish, Boston (1970, 75)
6. R. Millmen and G. Parker : Elements of Differential Geometry, Prentice Hall Inc Englewood Cliffs NJ (1977)
7 I. Singer and J.A. Thorpe : Lecture Notes on Elementary Topology and Geometry, UTM, Springer Verlag, NY (1967)

MT4E13 REPRESENTATION THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

Text Book : Walter Ledermann, Introduction to Group Characters(Second Edition)

Module - I

Introduction, G- modules, Characters, Reducibility, Permutation Representations, Complete reducibility, Schur's lemma, The commutant(endomorphism) algebra. (Sections: 1.1 to 1.8)

Module - II

Orthogonality relations, the group algebra, the character table, finite abelian groups, the lifting process, linear characters. (section: 2.1 to 2.6)

Module - III

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)

REFERENCES

[1] C. W. Kurtis and I. Reiner, Representation Theory of Finite Groups and Associative Algebras, John Wiley & Sons, New York(1962)

[2] Faulton, The Reprsentation 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).

[4] I. Schur, Theory of Group Characters, Academic Press, London (1977).

[5] J.P. Serre, Linear Reprsentation of Finite Groups, Graduate Text in Mathematics, Vol 42, Springer (1977).

MT4E14 WAVELET THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

TEXT :Michael. W. Frazier, "An Introduction to Wavelets through Linear Algebra", Springer, Newyork, 1999.

Module - I

The discrete Fourier transforms :Basic Properties of Discrete Fourier Transforms , Translation invariant Linear Transforms ,The Fast Fourier Transforms.

Construction of wavelets on Z_N - The First Stage , Construction of Wavelets on Z_N – The Iteration Step.

Module - II

Wavelets on Z**:** l^2 (Z), Complete orthonormal sets in Hilbert spaces , $L^2(-\pi,\pi)$ and Fourier series ,The Fourier Transform and convolution on l^2 (Z) , First stage Wavelets on Z , Implementation and Examples.

Module - III

Wavelets on R : L^2 (R) and approximate identities , The Fourier transform on R , Multiresolution analysis , Construction of MRA .

References:

1. C.K. Chui , An introduction to wavelets, Academic Press,1992

2. Jaideva. C. Goswami, Andrew K Chan, "Fundamentals of Wavelets Theory Algorithms and Applications", John Wiley and Sons, Newyork. , 1999.

3. Yves Nievergelt, "Wavelets made easy", Birkhauser, Boston,1999.

4. G. Bachman, L.Narici and E. Beckenstein , "Fourier and wavelet analysis", Springer, 2006

MT4E15 GRAPH THEORY

No. of credits: 4

Number of hours of Lectures/week : 5

TEXT:

J.A. Bondy and U.S.R.Murty : *Graph Theory with applications*. Macmillan

Module – I

Basic concepts of Graph. Trees, Cut edges and Bonds, Cut vertices, Cayley's Formula, The Connector Problem, Connectivity, Blocks, Construction of Reliable Communication Networks, Euler Tours, Hamilton Cycles, The Chineese Postman Problem, The Travelling Salesman Problem.

Module – II

Matchings, Matchings and Coverings in Bipartite Graphs, Perfect Matchings, The Personnel Assignment Problem, Edge Chromatic Number, Vizing's Theorem, The Timetabling Problem, Independent Sets, Ramsey's Theorem,

Module – III

Vertex Colouring-Chromatic Number, Brooks' Theorem, Chromatic Polynomial, Girth and Chromatic Number, A Storage Problem, Plane and Planar Graphs, Dual Graphs, Euler's Formula, Bridges, Kuratowski's Theorem, The Five-Colour Theorem, Directed Graphs, Directed Paths, Directed Cycles.

[Chapter 2 Sections 2.1(Definitions & Statements only), 2.2, 2.3, 2.4, 2.5; Chapter 3 Sections 3.1, 3.2, 3.3; Chapter 4 Sections 4.1(Definitions & Statements only), 4.2, 4.3, 4.4; Chapter 5 Sections 5.1, 5.2, 5.3, 5.4; Chapter 6 Sections 6.1,6.2,6.3; Chapter 7 Sections 7.1,7.2; Chapter 8 Sections 8.1, 8.2, 8.4, 8.5, 8.6; Chapter 9 Sections (9.1,9.2,9.3 Definitions & Statements only), 9.4, 9.5, 9.6; Chapter 10 Sections 10.1, 10.2, 10.3.

REFERENCES:

[1]. **F. Harary** : *Graph Theory*, Narosa publishers, Reprint 2013.

[2]. **Geir Agnarsson, Raymond Greenlaw:** Graph Theory Modelling, Applications and Algorithms, Pearson Printice Hall, 2007.

[3]. **John Clark and Derek Allan Holton** : *A First look at Graph Theory*, World Scientific (Singapore) in 1991 and Allied Publishers (India) in 1995

[4]. **R. Balakrishnan & K. Ranganathan** : *A Text Book of Graph Theory*, Springer Verlag, 2nd edition 2012.

PROJECT

The Project in this Programme is to be done in the III & IV Semesters with a total credit of 4 including Project Viva. The work load of the Project is 5 hours per week in each of the III & IV Semesters. The Project Report (Dissertation) should be self contained. It should contain an introduction, necessary background and a reference list in addition to the main content. Also it must contain certificates by the candidate and the supervising teacher stating the originality of the work. The main content may be of length not less than 30 pages in the A4 format with one and half line spacing.

Project Viva is to be conducted by a board consisting of one external and one internal (preferably the supervisor of the project) examiners and equal weightage must be given to the dissertation and the presentation of the student and half of that may be given to the viva. The maximum marks for the project is 100. In its evaluation, the dissertation consists of a maximum of 40 marks, the presentation by the candidate consists of a maximum of 40 marks and the viva voce consists of a maximum of 20 marks. There must be a 20 minute presentation by the student followed by 10 minutes viva.

UNIVERSITY OF CALICUT

Mark Sheet for Viva Voce of Project (MT4C17)

Name of Examination : IV Semester M.Sc (Mathematics)
Center of Examination :
Date of Examination :

Sl. No	**Register No.**	**Dissertation (in 40 Marks)**			**Presentation (in 40 Marks)**			**Viva Voce (in 20 Marks)**			**Total (in 100 Marks)**
		Int.	Ext	Avg.	Int.	Ext.	Avg.	Int.	Ext.	Avg	
1											
2											
3											
4									`		
5											
6											
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19											
20											

Internal Examiner **External Examiner**

Chairman

MT1V06 & MT3V16 VIVA VOCE EXAMINATIONS

Viva Voce in the FIRST and THIRD semesters are to be conducted in the presence of **two external examiners**. These viva voce must be based on the papers in the respective semesters. In the viva voce all the papers in that semester must be covered and each paper must have a minimum of 5 minutes duration. Total marks for Viva Voce is 50. Mark sheets for Viva Voce are given below.

UNIVERSITY OF CALICUT

Mark Sheet for Viva Voce (MT1V06)

Name of Examination : I Semester M.Sc (Mathematics) Viva Voce
Center of Examination :
Date of Examination :

Sl.No	Register No.	Maximum of 10 Marks for each Courses					Total (in 50 Marks)
		MT1C01	MT1C02	MT1C03	MT1C04	MT1C05	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
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16							
17							
18							
19							
20							

(Average mark of both the internal and external examiners marks are to be entered in the column corresponding to each course.)

Internal Examiner **External Examiner**

Chairman

UNIVERSITY OF CALICUT

Mark Sheet for Viva Voce (MT3V16)

Name of Examination : III Semester M.Sc (Mathematics) Viva Voce
Center of Examination :
Date of Examination :

Sl.No	Register No.	50 Marks to be distributed for the Courses With maximum of 15 marks for a course				Total (in 50 Marks)
		MT3C12	MT3C13	MT3C14	MT3C15	
1						
2						
3						
4						
5						
6						
7						
8						
9						
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15						
16						
17						
18						
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20						

(Average mark of both the internal and external examiners marks are to be entered in the column corresponding to each course.)

Internal Examiner **External Examiner**

Chairman

EVALUATION AND GRADING

There shall be University examinations at the end of each semester.

The evaluation scheme for each course shall contain two parts.

(a) Internal Evaluation – 20 marks. This is distributed as:

One Mid-Semester Examination -10 marks

Assignment/Seminar – 6 marks

Attendance – 4 marks

(b) External Evaluation – 80 marks

Both Internal and External evaluation shall be carried out in the mark system instead of direct grading. After the external evaluation the marks are to be submitted to the University. All other calculations in grading are done by the university, using the software.

Question Paper Pattern for the written examination of the Elective Course: MT4E07 Computer Oriented Numerical Analysis

For the Elective Course MT4E07: Computer Oriented Numerical Analysis there will be a Theory written examination and a practical examination each of duration one and half hours. The valuation will be done by marking System. The question paper for the written examination will consists of 5 short answer questions, each of 2 marks, 6 paragraph type questions each of 5 marks and 2 essay type questions, each of 10 marks. **All short answer questions are to be answered while 4 paragraph type questions and 1 essay type questions are to be answered with a total of 40 marks. See the table below. The questions are to be evenly distributed over the entire syllabus.**

Sl.No.	Type of Question	Total No. of Questions	No. of Questions to be Answered	Mark per Question
	Short Answer Type	5	5	2
	Paragraph Type	6	4	5
	Essay Type	2	1	10
			Total Marks	40

PRACTICAL

Equal weightage to be given for methods and programming. A candidate appearing for the practical examination should submit his/her record to the examiners. The candidate is to choose two problems from part A and three problems from part B by lot. Let him/her do any one of the problems got selected from each section on a computer. The examiners have to give data to check the program and verify the result. A print out of the two programs along with the solutions as obtained from the computer should be submitted by the candidate to the examiners. These print outs are to be treated as the answer sheets of the practical examination. The part A of the practical examination will carry 12 marks, Part B 18 marks and the practical record carries 10 marks.

Procedure for conducting the Practical Examination

Those colleges offering CONA should inform the Controller of examinations, University of Calicut, well in advance of the number of candidates likely to appear for the practical examination at their college. They should also indicate the number of batches required for completing the practical examination on the basis that only two candidates are to do practical on one computer a day. In case, due to some technical problems like power failure or system break down, practical could not be conducted on the specified day, the examiners can choose an alternate day to conduct the examination in fresh. But the matter along with the new dates for the conduct of examination at the centre should be brought to the notice of the Controller of Examinations. Rules of the Viva and the mark sheet of practical exam are given below. Copies of these may be given to the respective departments/colleges.

UNIVERSITY OF CALICUT

Rules for the Conduct of Viva Voce of Project and Practical

M.Sc. Mathematics

1. Evaluation of candidates is to be done by both the Internal and External Examiners.
2. Both the Internal and External Examiners will assign Marks.
3. The Marks by both Internal and External Examiners are to be recorded on the same Mark Sheet.
4. The Mark Sheet is to be consolidated and must be signed by both the Internal and External Examiners.

5. Consolidation of Marks is by finding the average of the Marks assigned by the Internal and External Examiners.
6. The proforma of Mark Sheet must be sent to the examiners along with the respective appointment letters of the Examiners.

UNIVERSITY OF CALICUT

Mark Sheet for Practical Examination of
Computer Oriented Numerical Analysis (MT4E07)

Name of Examination : IV Semester M.Sc (Mathematics)
Center of Examination :
Date of Examination :

Sl. No.	Register No.	Part A Program (12 Marks)			Part B Program (18 Marks)			Record (10 Marks)			Total (40 Marks)
		Int. Ex.	Ext. Ex	Avg.	Int. Ex.	Ext. Ex	Avg.	Int. Ex.	Ext. Ex	Avg.	
1											
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Internal Examiner **External Examiner**

Chairman

QUESTION PAPER PATTERN FOR THE WRITTEN EXAMINATIONS OF ALL OTHER COURSES

For each course there will be an END SEMESTER EXAMINATION (EXTERNAL Examination) of 3 hours duration. The mark system is followed instead of direct grading for each question.

Time Three Hours   Maximum 80 Marks

The question paper may be divided into **three** parts.

Part I There may be **5** questions, each of **3** marks. (Maximum two question from each module –syllabus of a paper is having three modules)

All the questions are to be answered.
A maximum time of **6** Minutes may be allotted for each question.

The questions may be to define terms, perform simple calculations, give examples, statement of theorem, provide counter examples, justification of certain statements given, etc.
Proof of theorems may be avoided in this part.

Part II There may be **9** questions, each of **5** marks. (**Three** questions from each module)
Any **7** questions are to be answered.
A maximum time of **12** Minutes may be allotted for each question.

The questions may be to analyze the necessity of conditions in a definition/statement of theorem, perform calculations, proof of small results, deducing a corollary from a theorem after stating it, problems, Illustration of a theorem with examples after stating it etc.
Tricky questions may be included in this part.

Part III There may be **4** questions, each of **10** marks. (Minimum **one** question from each module)
Any **3** questions are to be answered.
A maximum time of **22** Minutes may be allotted for each question.

The questions may be to state and prove theorem, writing proof of given statements, Proof of a theorem and deducing special cases of it, etc.

	Type of Qn	No. of Qns	Mark per Qn	Total Mark	Time (Minutes)
Part I	Short Answer	5 out of 5	3	15	30
Part II	Medium type	7 out of 9	5	35	84
Part III	Essay type	3 out of 4	10	30	66
				80	180 minutes

SEMESTERWISE MARKS AND TOTAL MARKS

SEMESTER – I

Title of the Course and Credits	Marks
Algebra- I - 4	**100**
Linear Algebra - 4	**100**
Real Analysis-I - 4	**100**
Number Theory - 4	**100**
Discrete Mathematics - 4	**100**
Viva Voce - 2	**50**

SEMESTER – II

Title of the Course and Credits	Marks
Algebra- II - 4	**100**
Real Analysis-II - 4	**100**
TOPOLOGY - 4	**100**
ODE and CALCULUS OF VARIATIONS - 4	**100**
OPERATIONS RESEARCH - 4	**100**

SEMESTER – III

Title of the Course and Credits	Marks
MULTIVARIABLE CALCULUS AND GEOMETRY - 4	**100**
COMPLEX ANALYSIS - 4	**100**
FUNCTIONAL ANALYSIS - 4	**100**
PDE AND INTEGRAL EQUATIONS - 4	**100**
PROJECT	
Viva Voce - 2	**50**

SEMESTER – IV

Title of the Course and Credits		Marks
ELECTIVE - 1	- 4	100
ELECTIVE - 2	- 4	100
ELECTIVE - 3	- 4	100
ELECTIVE - 4	- 4	100
PROJECT	- 4	100

TOTAL CREDITS AND MARKS

SEMESTER	CREDITS	MARKS
I	22	550
II	20	500
III	18	450
IV	20	500
TOTAL	80	2000

MODEL QUESTION PAPERS

FIRST SEMESTER M.Sc DEGREE EXAMINATION ---2014

(CUCSS)

Mathematics

MT 1C 01- ALGEBRA 1

(2014 Admissions)

Time: Three Hours | Maximum: 80

Part A

Answer **all** questions.

Each question has 3 marks.

1. Show that the isometries of $\mathbb{R}^2$ form a subgroup of the group of all permutations of $\mathbb{R}^2$

2. Find the order of (8, 4, 10) in the group $\mathbb{Z}_{12} \times \mathbb{Z}_{60} \times \mathbb{Z}_{24}$.

3. Find the number of orbits in {1,2,3,4,5,6,7,8} under the subgroup of S_8 generated by (1,3) and (2, 4, 7).

4. Let $\phi: \mathbb{Z}_{18} \rightarrow \mathbb{Z}_3$ be the homomorphism such that $\phi(1) = 2$. List the cosets in $\mathbb{Z}_{12}$/K, showing the elements in each coset.

5. Find all zeroes of $x^3 + 2x + 2$ in $\mathbb{Z}_7$.

Part B

Answer any **seven** questions out of nine questions.

Each question carries 5 marks.

6. Prove that every finite group G of isometries of the plane is isomorphic to either $\mathbb{Z}_n$ or to a dihedral group D_n for some positive integer n.

7. Prove that the group $\mathbb{Z}_m \; x \; \mathbb{Z}_n$ is isomorphic to $\mathbb{Z}_{mn}$ if and only if m and n are relatively prime.

8. Classify the group $\mathbb{Z}_4 \, x \, \mathbb{Z}_2 / \{0\} \; x \; \mathbb{Z}_2$ according to the fundamental theorem of finitely generated abelian group.

9. Prove that if G has a composition series and if N is a proper normal subgroup of G then there exists a composition series containing N

10. Can a group of order 15 be simple? Verify.

11. Find the conjugate classes of S_3 and write the class equation.

12. Prove that for a prime number p, every group G of order p2 is abelian.

13. Factorize $x^4 + 3\,x^3 + 2x + 4$ in $\mathbb{Z}_5\,[x]$.

14. Show that $f(x) = x^4 - 2x^2 + 8x + 1$ viewed in Q[x] is irreducible over Q.

15. Let $\mathbb{R}$ be a commutative ring and let $a \in \mathbb{R}$. Show that $I_a = \{a \in \mathbb{R} \;\; / ax = 0\}$ is an ideal of $\mathbb{R}$.

Part C

Answer any three questions.

Each question carries 10 marks.

16. State Lagrange's theorem. Illustrate the fallicity of the converse of theorem of Lagrange.

17. State and prove second isomorphism theorem.

18. a) Describe the properties of a simple group

b) Prove that no group of order 48 is simple.

19. Prove that quaternion form a skew field under addition and multiplication.

SECOND SEMESTER M.Sc DEGREE EXAMINATION, JANUARY 2014

(CUCSS)

Mathematics

MT 2C 07- ALGEBRA 11

Time: Three Hours Maximum: 80

Part A

Answer **all** questions.

Each question has 3 marks.

1. Prove or disprove any two irreducibles in any UFD are associates.
2. Show that 2 is equal to the product of a unit and the square of an irreducible in Z[i]. Describe all extension of the identity map of Q to an isomorphism mapping $Q(\sqrt[3]{2})$ onto a subfield of $\overline{Q}$.
3. Let E = Q ($\sqrt{2}$, $\sqrt{3}$, $\sqrt{5}$). Find [E : Q]

4. Prove or disprove that every algebraically closed field is perfect.
5. Define symmetric function and express the symmetric function in y_1,y_2,y_3 over Q as a rational function of the elementary symmetric functions S_1,S_2,S_3 $y_1^2+y_2^2+y_3^2$.

Part B

Answer any **seven** questions out of nine questions.

Each question carries 5 marks.

6. State and prove Brouwer-Fixed Point theorem .

7. Show that if $A \rightarrow^{g} B \rightarrow^{h} C \rightarrow^{i} D \rightarrow^{j} E \rightarrow^{k} F$ is an exact sequence if additive groups, then the following are equivalent
   a). h and j both map everything onto 0
   b). i is an isomorphism of C onto D
   c). g is onto B and k is one-to-one

8. Prove that every PID is a UFD and the integral domain Z is a UFD .

9. Let D be a PID . Every element that is neither 0 nor a unit in D is a product of irreducible. Is Z[X] a PID?

10. If D is a UFD, then prove that a finite product of primitive polynomials in D[X] is again primitive.

11. Let F be a finite field of characteristic p. Then the prove that map $\sigma_p : F \rightarrow F$ defined by $\sigma_p(a) = a^p$, for $a \in F$ is the Frobenius automorphism of F . Also , $F_{\{\sigma_p\}} \cong Z_p$.

12. If $F \leq E \leq K$, where K is finite extension field of the field F, then show that {K:F} = {K:E}{E:F} .

13. Let F be a field of characteristic 0 and let $a \in F$. If K is the splitting field of $X^n - a$ over F, then G(K/F) is solvable group .

14. Let p be an odd prime in Z. Then $p = a^2 + b^2$ for integers aand b in Z iff $p \equiv 1 \pmod 4$.

Part C

Answer any three questions.

Each question carries 10 marks.

15. a). State and prove the conjugation isomorphism theorem.

    b). Complex zeros of polynomials with real coefficients occur in conjugate pairs.

17. State and prove Isomorphism Extension theorem.

18.Prove that a finite extension of a field of characteristic zero is simple extension .

19. Let $<\alpha>$ be a nonzero principal ideal in Z[i]

   a). Show that Z[i]/ $<\alpha>$ is finite ring

   b). Show that if π is an irreducible of Z[i], then Z[i]/ π is a field

   c). find the order and characteristic of the following fields

   (i) Z[i]/<1+i> (ii) Z[i]/<1+2i>

FOURTH SEMESTER M.SC MATHEMATICS JANUARY 20--

(CUCSS)

MATHEMATICS

MT4E01-COMMUTATIVE ALGEBRA

(2014 Admissions)

Time: Three hours   Maximum: 80

Part A

Answer **all** questions.

Each question has **3** marks.

1. Show that $(z/mz) \otimes (z/nz) = 0$ if m and n are co prime.
2. Verify whether the union of any two ideals is also an ideal ? Illustrate with an example
3. Justify that any principal ideal domain is Noetherian.
4. Prove that B is a local ring and m = ker (g) is its maximal ideal.
5. Prove by an example that a ring with only one prime ideal need not be Noetherian.

Part B

Answer any **seven** from the following **nine** questions

Each question has **5** marks**.**

6. Let x be a nilpotent element of a ring A. Show that Hx is a unit of A. Deduce that the Sum of a nilpotent element and a unit is a unit?

7. Prove that the nil radical of A is the intersection of the prime ideals of A.

8. State and prove going-up theorem? Give an example to show the ring Z satisfies a.c.c ,but not d.c.c.

9. If a_i, a_j are co-prime whenever $i \neq j$, prove that

   i. $\prod a_i = \cap a_i$
   ii. Φ is surjective if and only if a_i , a_j are co-prime whenever $i \neq j$.
   iii. Φ is injective if and only if $\cap a_i = (0)$

10. Let $\mathbf{O \to N^I \to N \to N^{II} \to 0}$ be an exact sequence with N^{II} flat. Prove that N^I is flat if and only if N is flat .

11. A ring A is absolutely flat if every A-module is flat. Prove that the following are equivalent:

i. A is absolutely flat.
ii. Every principal ideal is idempotent.
iii. Every finitely generated ideal is a direct summand of A.

12. Let (B,g) be a maximal element of ∑. Prove that B is a valuation ring of the field K.

13. Prove that if the zero ideal is decomposable, then the set D of zero divisors of a ring A is the union of the prime ideals belonging to D.

14. Show that an Artin ring A is uniquely (upto isomorphism) a finite direct product of Artin local rings.

Part C

Answer any **three** from the following four questions

Each question has **10** marks.

25.Let A be a ring, n its nilradical show that the following are equivalent:

i. A has exactly one prime ideal
ii. every element of A is either a unit or nilpotent
iii. A/η is a field

26. Prove that S^{-I} A is a flat A – module.

27. a)State and prove Hilbert's basis theorem

b) Prove that if A is Noetherian, so is $A[x_1.x_2,\ldots\ldots,x_n]$

28. a)Prove that in an Artin ring the nilradical η is nilpotent.

b) prove that a ring A is Artin If and only if A is Noetherian and dim A=0.

c) Show that in an Artin ring nilradical is equal to Jacobson radical.