ST. THOMAS' COLLEGE (AUTONOMOUS)
THRISSUR, KERALA – 680001

Affiliated to University of Calicut
Nationally reaccredited with 'A' Grade

VERITAS VOS LIBERABIT

CURRICULUM AND SYLLABUS
FOR
POSTGRADUATE PROGRAMME IN MATHEMATICS

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
(w.e.f. 2020 Admission onwards)

SEMESTER 1

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Audit Course
MTH1C01	Algebra- I	4	5	core
MTH1C02	Linear Algebra	4	5	core
MTH1C03	Real Analysis I	4	5	core
MTH1C04	Discrete Mathematics	4	5	core
MTH1C05	Number Theory	4	5	core
MTH1A01	Ability Enhancement Course[a]	4	0	Audit Course

SEMESTER 2

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/ Elective
MTH2C06	Algebra- II	4	5	core
MTH2C07	Real Analysis II	4	5	core
MTH2C08	Topology	4	5	core
MTH2C09	ODE & calculus of variations	4	5	core
MTH2C10	Operations Research	4	5	core
	Professional Competency Course [a]	4	0	Audit Course

SEMESTER 3

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Elective
MTH3C11	Multivariable Calculus &Geometry	4	5	core
MTH3C12	Complex Analysis	4	5	core
MTH3C13	Functional Analysis	4	5	core
MTH3C14	PDE & Integral Equations	4	5	core
	Elective I*	3	5	Elec.

SEMESTER 4

Course Code	Title of the Course	No. of Credits	Work Load Hrs./week	Core/Elective
MTH4C15	Advanced Functional Analysis	4	5	Core
	Elective II**	3	5	Elec.
	Elective III**	3	5	Elec.
	Elective IV**	3	5	Elec.
MTH4P01	Project	4	5	Core
MTH4 V01	Viva Voce	4		Core

[a]Evaluation of these courses will be as per the latest PG regulations.

* This Elective is to be selected from list of elective courses in third semester

** ThisElectiveistobeselectedfromlistofelectivecoursesinfourthsemester

ListofElectiveCoursesinThirdSemester

1.MTH3E01 Coding theory

2. MTH3E02 Cryptography

3. MTH3E03Measure&Integration

4. MTH3E04 ProbabilityTheory

List of Elective Courses in Fourth Semester

1. MTH4E05 Advanced Complex Analysis

2. MTH4E06 Algebraic Number Theory

3.MTH4E07 Algebraic Topology

4.MTH4E08 Commutative Algebra

5.MTH4E09 Differential Geometry

6.MTH4E10 FluidDynamics

7. MTH4E11 Graph Theory

8.MTH4E12RepresentationTheory

9.MTH4E13 WaveletTheory

ABILITY ENHANCEMENT COURSE (AEC)

Successfulfulfilmentofanyoneofthefollowingshallbeconsideredasthecompletionof AEC. (i) Internship, (ii) Class room seminar presentation, (iii) Publications, (iv)Case study analysis, (v) Paper presentation, (vi) Book reviews. A student can select any one of these asAEC.

I. **Internship:** Internship of duration 5 days under the guidance of a faculty in aninstitution/departmentother thantheparentdepartment.Acertificateofthesameshould beobtainedandsubmittedtotheparentdepartment.

II. **Classroomseminar:**Oneseminarofdurationonehourbasedontopicsinmathematics beyond the prescribed syllabus.

III. **Publications:**Onepaperpublishedinconferenceproceedings/Journals.Acopyofthe sameshouldbesubmittedtotheparentdepartment.

IV. **Case study analysis:** Report of the case study should be submitted to the parent department.

V. **Paperpresentation:**Presentationofapaperinaregional/national/internationalseminar/ conference.Acopyofthecertificateofpresentationshouldbesubmittedtothe parentdepartment.

VI. **Book Reviews:** Review of a book. Report of the review should be submitted to the parentdepartment.

PROFESSIONAL COMPETENCY COURSE (PCC)

A student can select any one of the following as Professional Competency course:

1. Technical writing with LATEX.
2. Scientific Programming with Scilab.
3. Scientific Programming withPython.

PROJECT

TheProjectReport(Dissertation)shouldbeselfcontained.Itshouldcontaintableofcontents,introduction,atleastthreechapters,bibliographyandindex.Themaincontentmay be of length not less than 30 pages in the A4 format with one and half line spacing. The projectreportshouldbepreparedpreferablyinLATEX.Theremustbeaprojectpresentation by the student followed by a viva voce. The components and weightage of External and Internal valuation of the Project are asfollows:

Components	External (weightage)	Internal (weightage)
Relevance of the topic & statement of problem	4	1
Methodology & analysis	4	1
Quality of Report & Presentation	4	1
Viva Voce	8	2
Total weightage	20	5

The external project evaluation shall be done by a Board consisting two External Examiners. The Grade Sheet is to be consolidated and must be signed by the External Examiners.

MTH4V01 VIVA VOCE EXAMINATIONS

TheComprehensiveVivaVoceistobeconductedbyaBoardconsistingoftwoExternal Examiners. The viva voce must be based on the core papers of the entire programme. Thereshouldbequestionsfromatleastonecourseofeachofthesemesters I,II,and III. Total weightage of viva voce is 15. The same Board of two External Examiners shall conduct both the project evaluation and the comprehensive viva voce examination. The Board of Examiners shall evaluate at most 10 students per day.

EVALUATION AND GRADING

Theevaluationschemeforeachcourseexceptauditcoursesshallcontaintwoparts.

(a)**InternalEvaluation:** 20%Weightage

(b)**ExternalEvaluation:** 80%Weightage

Both the Internal and the External evaluation shall be carried out using direct grading systemasperthegeneralguidelinesoftheUniversity.

Internalevaluationmustconsistof

(i) 2 tests (ii) one assignment (iii) one seminar and (iv) attendance, with weightage 2 for tests (together) and weightage 1 for each other component.

Internal Examination:

Eachofthetwointernaltestsistobea10weightageexaminationofdurationonehour indirectgrading.Theaverageofthefinalgradepointsofthetwotestscanbeusedtoobtainthefinalconsolidatedlettergradefortests(together)accordingtothefollowingtable.

Average grade point (2 tests)	Grade for Tests	Grade Point for Tests
4.5 to 5	A+	5
3.75 to 4.49	A	4
3 to 3.74	B	3
2 to 2.99	C	2
Below 2	D	1
Absent	E	0

Range of Attendance	Grading
>= 90 %	A +
85 % < = Attendance < 90 %	A
80 % < = Attendance < 85 %	B
75 % < = Attendance < 80 %	C
70 % < = Attendance < 75 %	D
< 70 %	E

Table 1: Internal Grade Calculation: Examples

Tests	Grade Point ofTest1	Grade Point ofTest2	Average Test Grade Point	Test Grade	Test Grade Point	Test Weightage	Test Weighted Grade Point
Student1	4.8	3.5	4.15	A	4	2	8
Student2	5	4.8	4.9	A+	5	2	10
Student3	2.3	4.7	3.5	B	3	2	6

Assignment	Assignment Grade	Assignment Grade Point	Assignment Weightage	Assignment Weighted Grade Point
Student1	A+	5	1	5
Student2	A	4	1	4
Student3	C	2	1	2

Seminar	Seminar Grade	Seminar Grade Point	Seminar Weightage	Seminar Weighted Grade Point
Student1	B	3	1	3
Student2	A+	5	1	5
Student3	D	1	1	1

Attendance	Attendance Grade	Attendance Grade Point	Attendance Weightage	Attendance Weighted Grade Point
Student1	A+	5	1	5
Student2	A+	5	1	5
Student3	C	2	1	2

Consolidation	Total Weighted Grade Point	Total Weightage	Total Internal Grade Point	Final Internal Grade
Student1	21	5	21/5 = 4.2	A+
Student2	24	5	24/5=4.8	O
Student3	11	5	11/5 = 2.2	F

Question Paper Pattern for the End semester written examinations

For each course there will be an End semester examination of duration 3 hours.Thevaluation will be done by Direct Grading System.

Eachquestionpaperwillconsistof8shortanswer questionseachofweightage1,9paragraphtypequestionseachofweightage2,and 4essay type questions each of weightage 5. All short answer questions are to be answered while 6 paragraph type questions and 2 essay type questions are to be answered with a total weightage of 30. The questions are to be evenly distributed over the entire syllabus.(see the model question paper).More specifically, each questionpaper consists of three parts viz Part A, Part B and Part C. Part A will consist of 8 short answer type questions each of weightage 1 of which at least 2 questions should be from each unit. Part B will consist of 9paragraph type questions each of weightage 2 of which at least 3 questions should be from each unit. Part C will consist of four essay type questions each of weightage 5 of which 2 should be answered. These questions should cover the entire syllabus of thecourse.

Industrial Visit:

It is compulsory that every student has to undertake study tour of 1-2 days to visit Organizations / Institutes involved in higher education under the guidance of teachers. Submit a visit report countersigned by the Head of the department during the project evaluation. If a student fails to undergo the study tour he/she may not be permitted to attend the project examination.

POST GRADUATE PROGRAM OUTCOMES:

At the end of Post Graduate Program at St. Thomas College (Autonomous), a student would have:

PO 1	Attained profound **Expertise in Discipline**.
PO 2	Acquired **Ability to function in multidisciplinary Domains**.
PO 3	Attained ability to exercise **Research Intelligence** in investigations and Innovations.
PO 4	Learnt Ethical Principles and be committed to **Professional Ethics**.
PO 5	Incorporated **Self-directed and Life-long Learning**.
PO 6	Obtained Ability to maneuver in diverse contexts with **Global Perspective**.
PO 7	Attained **Maturity to respond to one's calling**.

Program Specific Outcomes:

PSO 1	Develop a strong base in theoretical and applied Mathematics.
PSO 2	Acquire their analytical thinking, logical deductions and rigor in reasoning.
PSO 3	Apply the tools to model the problems mathematically, analyze data quantitatively and create the ability to access and communicate mathematical information.
PSO 4	Acquire knowledge in recent developments in various branches of Mathematics and thus pursue research.

Detailed Syllabi

SEMESTER I

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
1	**MTH1C01**	**Core**	**ALGEBRA - I**	**4**	**5**					
CO	CO Statement									
CO 1	Create knowledge of plane isometries					Cr	(C,P)	15	2	1
CO 2	Understand group action and its applications					U	(C,P)	10	2	
CO 3	Apply Sylow theorem to solve problems in group theory					Ap	(C,P)	25	3	
CO 4	Understand group presentation					U	C	15	3	
CO 5	Explain polynomials over a ring.					U	(C,P)	15	3	

TEXT : JOHN B. FRALEIGH, A FIRST COURSE IN ABSTRACT ALGEBRA(7^{th}Edn.), Pearson Education Inc., 2003.

Module 1

PlaneIsometries,Directproducts&finitelygeneratedAbelianGroups,FactorGroups, Factor-Group Computations and Simple Groups, Group action on a set, Applications of G-settocounting[Sections12,11,14,15,16,17].

Module 2

Isomorphismtheorems,Seriesofgroups,(OmitButterflyLemmaandproofoftheSchreier Theorem),Sylowtheorems,ApplicationsoftheSylowtheory,FreeGroups(OmitAnother lookatfreeabeliangroups)[Sections34,35,36,37,39].

Module 3

GroupPresentations,Ringsofpolynomials,Factorizationofpolynomialsoverafield,N on Commutativeexamples,Homomorphismandfactorrings [sections40,22,23,24,26].

References:

[1] **N. Bourbaki**: Elements of Mathematics: Algebra I, Springer;1998.

[2] **Dummit and Foote**: Abstract algebra(3rd edn.); Wiley India;2011.

[3] **P.A. Grillet**: Abstract algebra(2nd edn.); Springer;2007

[4] **I.N. Herstein**: Topics in Algebra(2nd Edn); John Wiley & Sons,2006.

[5] **T.W. Hungerford**: Algebra; Springer VerlagGTM 73(4th Printing);1987.

[6] **N.Jacobson**:BasicAlgebra-Vol.I;HindustanPublishingCorporation(India),Delhi; 1991.

[7] **T.Y. Lam**: Exercises in classical ring theory(2nd edn); Springer;2003.

[8] **C. Lanski**: Concepts in Abstract Algebra; American Mathematical Society;2010.

[9] **N.H. Mc Coy**: Introduction to modern algebra, Literary Licensing, LLC;2012.

[10] **S. M. Ross**: Topicsin Finite and Discrete Mathematics; Cambridge; 2000.

[11] **J. Rotman**: An Introduction to the Theory of Groups(4th edn.); Springer,1999.

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
2	**MTH1 C02**	**Core**	**Linear Algebra**	**4**	**5**					
CO	CO Statement									
CO 1	Understand properties of vector spaces					U	(C,P)	25	1	3
CO 2	Study linear transformations					U	(C,P)	15	2	
CO 3	Illustrate elementary canonical forms					U	(C,P)	10	2	
CO 4	Develop an idea of inner product spaces					Ap	(C,P)	15	3	
CO 5	Apply orthonormalization techniques to solve problems					Ap	(C,P)	15	6	

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

Module 1

Vector Spaces & Linear Transformations [Chapter 2 Sections 2.1 - 2.4; Chapter 3, Sections3.1 to 3.3 from the text]

Module 2

Linear Transformations (continued) and Elementary Canonical Forms [Chapter 3 Sections3.4 - 3.7; Chapter 6, Sections 6.1 to 6.4 from the text]

Module 3

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] **A. K. Hazra**: Matrix: Algebra, Calculus and generalised inverse- Part I; Cambridge International Science Publishing;2007.

[3] **I. N. Herstein**: Topics in Algebra; Wiley Eastern Ltd Reprint;1991.

[4] **S. Kumaresan**: Linear Algebra-A Geometric Approach; Prentice Hall of India;2000.

[5] **S. Lang**: Linear Algebra; Addison Wesley Pub.Co.Reading, Mass;1972.

[6] **S. Maclane and G.Bikhrkhoff**: Algebra; Macmillan Pub Co NY; 1967.

[7] **N. H. McCoy and R. Thomas**:Algebra; Allyn Bacon Inc NY; 1977.

[8] **R. R. Stoll and E.T.Wong**: Linear Algebra; Academic Press International Edn; 1968.

[9] **G. Strang**: linear algebra and its applications(4th edn.); Cengage Learning;2006.

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
3	**MTH1 C03**	**Core**	**Real Analysis I**	**4**	**5**					
CO	CO Statement									
CO 1	Construt an idea of basic topology					Ap	(C,P)	25	1	2
CO 2	Understand differentiation and related theorems					U	(C,P)	15	2	
CO 3	Understand differentiation of vector valued functions					U	(C,P)	10	6	
CO 4	Develop knowledge of Riemann Stieltjes integral					Ap	(C,P)	15	3	
CO 5	Infer uniform continuity and uniform convergence					U	(C,P)	15	3	

TEXT: RUDIN W., PRINCIPLES OF MATHEMATICAL ANALYSIS (3^{rd}Edn.), Mc.Graw-Hill, 1986.

Module 1

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,InfinitelimitsandLimitsatInfinity[Chapter2&Chapter4].

Module 2

DifferentiationThederivativeofarealfunction,MeanValuetheorems,Thecontinuity of Derivatives, L Hospitals Rule, Derivatives of Higher Order, Taylors Theorem, Differ- entiation of Vector valued functions. The Riemann Stieltjes Integral, - Definition and Existenceoftheintegral,propertiesoftheintegral,IntegrationandDifferentiation[Chapter 5&Chapter6uptoandincluding6.22].

Module 3

TheRiemannStieltjesIntegral(Continued)-IntegrationofVectorvector-valuedFunc- tions,Rectifiablecurves.SequencesandSeriesofFunctions-DiscussionofMainproblem, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Inte- gration,UniformconvergenceandDifferentiation.EquicontinuousFamiliesofFun ctions, The Stone Weierstrass Theorem[Chapters 6 (from 6.23 to 6.27) & Chapter 7 (upto and including 7.27only)].

References:

[1] **H. Amann and J.Escher**: Analysis-I; Birkhuser; 2006.
[2] **T. M. Apostol**: Mathematical Analysis(2nd Edn.); Narosa;2002.
[3] **R. G. Bartle**: Elements of Real Analysis(2nd Edn.); Wiley International Edn.;1976.
[4] **R. G. Bartle and D.R. Sherbert**: Introduction to Real Analysis; John WileyBros; 1982.
[5] **J.V.Deshpande**:MathematicalAnalysisandApplications-anIntroduction;Alpha Science International;2004.
[6] **V. GanapathyIyer**: Mathematical analysis; TataMcGrawHill; 2003.
[7] **R. A. Gordon**: Real Analysis- a first course(2nd Edn.); Pearson;2009.
[8] **F. James**: Fundamentals of Real analysis; CRC Press;1991.
[9] **A. N. Kolmogorov and S. V. Fomin**: Introductory Real Analysis; Dover Publica- tionsInc;1998.
[10] **S. Lang**: Under Graduate Analysis(2nd Edn.);Springer-Verlag; 1997.
[11] **M. H. Protter and C. B. Moray**: A first course in Real Analysis; Springer VerlagUTM;1977.
[12] **C. C. Pugh**: Real Mathematical Analysis, Springer;2010.
[13] **K. A. Ross**: Elementary Analysis- The Theory of Calculus(2nd edn.); Springer; 2013.
[14] **A.H.SmithandJr.W.A.Albrecht**:Fundamentalconceptsofanalysis;Prentice Hall of India; 1966
[15] **V. A. Zorich**: Mathematical Analysis-I; Springer;2008.

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
4	**MTH1 C04**	**Core**	**Discrete Mathematics**	**4**	**5**					
CO	CO Statement									
CO 1	State concepts of order relations.					U	C	10	1	3
CO 2	Interpret Boolean algebra and their properties					U	(C,P)	15	2	
CO 3	Develop concepts of graph and related terms					Ap	(C,P)	15	6	
CO 4	Analyze characterization of special graphs					An	(C,P)	20	6	
CO 5	Construct concepts of automata and formal languages					Ap	(C,P)	20	3	

TEXT 1: R. BALAKRISHNAN and K. RANGANATHAN, A TEXT BOOK OF GRAPHTHEORY, Springer-Verlag New York, Inc., 2000.

TEXT 2: K. D JOSHI, FOUNDATIONS OF DISCRETE MATHEMATICS, New AgeInternational(P) Limited, New Delhi, 1989.

TEXT 3: PETER LINZ, AN INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA (2ndEdn.), Narosa Publishing House, New Delhi,1997.

Module 1

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

Module 2

Basic concepts, Subgraphs, Degree of vertices, Paths and connectedness, Automor- phism of a simple graph, Operations on graphs, Vertex cuts and Edge cuts, Connectivity andEdgeconnectivity,Trees-Definition,CharacterizationandSimpleproperties,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 1 Chapter 1 Sections 1.1, 1.2, 1.3,1.4,1.5,1.7,Chapter3Sections3.1,3.2,Chapter4Section4.1(uptoandincluding4.1.10), Chapter 6; Section 6.1(upto and including 6.1.2), Chapter 8 ;Sections8.1(uptoand including 8.1.7), 8.2(upto and including 8.2.7), 8.3, 8.4.]

Module 3

Automata and Formal Languages: Introduction to the theory of Computation: Three basic concepts, some applications, Finite Automata: Deterministic finite accepters, Non deterministic accepters, Equivalence of deterministic and nondeterministic finite accepters. [TEXT 3 - Chapter 1 (sections 1.2 & 1.3); Chapter 2 (sections 2.1, 2.2 & 2.3)]

References:

[1] **J. C. Abbot**: Sets, lattices and Boolean Algebras; Allyn and Bacon, Boston;1969.

[2] **J. A. Bondy, U.S.R. Murty**: Graph Theory; Springer;2000.

[3] **S. M. Cioaba and M.R. Murty**: A First Course in Graph Theory and Combina- torics; Hindustan Book Agency;2009.**J. A. Clalrk**: A first look at Graph Theory; World Scientific; 1991.

[4] **Colman and Busby**: Discrete Mathematical Structures; Prentice Hall of India;1985.

[5] **C. J. Dale**: An Introduction to Data base systems(3rd Edn.); Addison Wesley Pub Co., Reading Mass;1981.

[6] **R. Diestel**: Graph Theory(4th Edn.); Springer-Verlag;2010

[7] **S. R. Givantand P. Halmos**: Introduction to boolean algebras; Springer;2009.

[8] **R. P. Grimaldi**: Discrete and Combinatorial Mathematics- an applied introduc- tion(5th edn.); Pearson;2007.

[9] **J. L. Gross**: Graph theory and its applications(2nd edn.); Chapman & Hall/CRC; 2005.

[10] **F. Harary**: Graph Theory; Narosa Pub. House, New Delhi;1992.

[11] **D. J. Hunter**: Essentials of Discrete Mathematics(3rd edn.); Jones and Bartlett Publishers;2015.

[12] **A. V. Kelarev**: Graph Algebras and Automata; CRC Press;2003

[13] **D. E. Knuth**: The art of Computer programming -Vols. I to III; Addison Wesley Pub Co., Reading Mass;1973.

[14] **C.L.Liu**:ElementsofDiscreteMathematics(2ndEdn.);McGrawHillInternational Edns. Singapore;1985.

[15] **L. Lovsz, J. Pelikn and K. Vesztergombi**: Discrete Mathematics: Elementary and beyond; Springer;2003.

[16] **J.G.MichaelsandK.H.Rosen**:ApplicationsofDiscreteMathematics;McGraw- HillInternationalEdn.(Mathematics&StatisticsSeries);1992.

[17] **NarasingDeo**:GraphTheorywithapplicationstoEngineeringandComputerSci- ence; Prentice Hall of India;1987.

[18] **W. T. Tutte**: Graph Theory; Cambridge University Press;2001

[19] **D. B. West**: Introduction to graph theory; Prentice Hall;2000.

[20] **R. J. Wilson** : Introduction to Graph Theory; Longman Scientific and Technical Essex(co-publishedwithJohnWileyandsonsNY);1985.

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
5	**MTH1 C05**	**Core**	**Number Theory**	**4**	**5**					
CO	CO Statement									
CO 1	Identify arithmetic functions and Dirichlet multiplication					An	(C,P)	20	1	1
CO 2	Explain importance of prime numbers					U	(C,P)	20	2	
CO 3	Discuss quadratic residue and quadratic reciprocity laws					Cr	(C,P)	15	2	
CO 4	Demonstrate concepts in cryptography.					U	(C,P)	10	3	
CO 5	Classify symmetric and asymmetric cryptosystems					An	(C,P)	15	6	

TEXT 1 :APOSTOL T.M., INTRODUCTION TO ANALYTIC NUMBER THEORY,Narosa Publishing House, New Delhi, 1990.

TEXT 2: KOBLITZ NEAL A., COURSE IN NUMBER THEROY AND CRYPTOGRAPHY, SpringerVerlag, NewYork,1987.

Module 1

ArithmeticalfunctionsandDirichletmultiplication;Averagesofarithmeticalfunctions
[Chapter2:sections2.1to2.14,2.18,2.19;Chapter3:sections3.1to3.4,3.9to3.12ofText 1]

Module 2

Some elementary theorems on the distribution of prime numbers
[Chapter 4: Sections4.1 to 4.10 of Text 1]

Module 3

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 1 and 2 of Text 2.]

References

[1] **A. Beautelspacher**: Cryptology; Mathematical Association of America (Incorpo- rated);1994

[2] **H. Davenport**: The higher arithmetic(6th Edn.); Cambridge Univ.Press;1992

[3] **G. H. Hardy and E.M. Wright**: Introduction to the theory of numbers; Oxford International Edn;1985

[4] **A. Hurwitz & N. Kritiko**: Lectures on Number Theory; Springer Verlag,Universi- text;1986

[5] **T. Koshy**: Elementary Number Theory with Applications; Harcourt / Academic Press;2002

[6] **D.Redmond**:NumberTheory;Monographs&TextsinMathematicsNo:220;Mar- cel Dekker Inc.; 1994

[7] **P. Ribenboim**: The little book of Big Primes; Springer-Verlag, NewYork; 1991

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

[9] **W. Stallings**: Cryptography and Network Security-Principles and Practices; PHI; 2004

[10] **D.R. Stinson**: Cryptography- Theory and Practice(2nd Edn.); Chapman & Hall / CRC (214. Simon Sing : The Code Book The Fourth Estate London);1999

[11] **J.Stopple**:APrimerofAnalyticNumberTheory-FromPythagorustoRiemann;Cambridge Univ Press;2003

[12] **S.Y. Yan**: Number Theroy for Computing(2nd Edn.); Springer-Verlag;2002

SEMESTER II

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>1</td><td>MTH2 C06</td><td>Core</td><td>Algebra- II</td><td>4</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Understand concepts of prime and maximal ideals</td><td>U</td><td>(C,P)</td><td>20</td><td>1</td><td rowspan="5">1</td></tr>
<tr><td>CO 2</td><td colspan="5">Explain algebraic extension field</td><td>U</td><td>C</td><td>10</td><td>3</td></tr>
<tr><td>CO 3</td><td colspan="5">Summarize separable extension field</td><td>U</td><td>(C,P)</td><td>25</td><td>3</td></tr>
<tr><td>CO 4</td><td colspan="5">Illustrate Galois theory</td><td>U</td><td>(C,P)</td><td>10</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Create an idea of cyclotomic extensions</td><td>Cr</td><td>(C,P)</td><td>15</td><td>6</td></tr>
</table>

TEXT: John B. Fraleigh: A FIRST COURSE IN ABSTRACT ALGEBRA(7*th* Edn.),Pearson Education Inc.,2003.

Module 1

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 2

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

Module 3

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

References

[1] **N. Bourbaki**: Elements of Mathematics: Algebra I, Springer;1998

[2] **Dummit and Foote**: Abstract algebra(3rd edn.); Wiley India;2011

[3] **M.H. Fenrick**: Introduction to the Galois correspondence(2nd edn.); Birkhuser;1998

[4] **P.A. Grillet**: Abstract algebra(2nd edn.); Springer;2007

[5] **I.N. Herstein**: Topics in Algebra(2nd Edn); John Wiley & Sons,2006.

[6] **T.W. Hungerford**: Algebra; Springer VerlagGTM 73(4th Printing);1987

[7] **C. Lanski**: Concepts in Abstract Algebra; American Mathematical Society;2010

[8] **R. Lidl and G.Pilz**Appli:ed abstract algebra(2nd edn.); Springer; 1998

[9] **N.H. Mc Coy**: Introduction to modern algebra, Literary Licensing, LLC;2012

[10] **J. Rotman**: An Introduction to the Theory of Groups(4th edn.); Springer;1999

[11] **I. Stewart**: Galois theory(3rd edn.); Chapman & Hall/CRC;2003

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
7	**MTH2 C07**	**Core**	**Real Analysis II**	**4**	**5**					
CO	**CO Statement**									
CO 1	Understand Lebesgue measure					U	C	15	1	2
CO 2	Develop concept of integration of non-negative functions					U	(C,P)	15	2	
CO 3	Explain functions of bounded variation					U	C	15	3	
CO 4	Interpret Lebesgue's differentiation theorem					U	(C,P)	15	3	
CO 5	Illustrate signed measures and related theorems					U	(C,P)	20	6	

TEXT : H. L.Royden,P. M. FitzpatrickH.L. REAL ANAYLSIS (4th Edn.), Prentice Hall of India,2000.

Module 1

The Real Numbers:Sets, Sequences and Functions
Chapter 1 : Sigma Algebra , Borel sets Section 1.4 : Proposition13
Lebesgue Measure Chapter 2 : Sections 2.1, 2.2 ,2.3 ,2.4 ,2.5 ,2.6,2.7 upto preposition19.
Lebesgue Measurable Functions Chapter 3 : Sections 3.1, 3.2 , 3.3

Module 2

Lebesgue Integration Chapter 4 : Sections 4.1, 4.2, 4.3, 4.4, 4.5 ,4.6
Lebesgue Integration: Further Topics Chapter 5 : Sections: 5.1, 5.2,5.3

Module 3

Differentiation and Integration Chapter 6 : Sections 6.1, 6.2, 6.3 6.4, 6.5,6.6
TheL^pspaces : Completeness and Approximation Chapter 7 : Sections 7.1 ,7.2

,7.3

References:

[1] **K B. Athreya and S N Lahiri:**,Measuretheory,Hindustan Book Agency,New Delhi,(2006).

[2] **R G Bartle:**, The Elements of Integration and LebsgueMesure ,Wiley(1995).

[3] **S K Berberian:** ,measure theory and Integration,TheMcMillanCompany,NewYork,(1965).

[4] **L M Graves:** ,The Theory of Functions of Real Variable Tata McGraw-Hill Book Co(1978)

[5] **P R Halmos:** , Measure Theory, GTM ,SpringerVerlag

[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 Com- pany,NewYork.

[8] **Terence Tao:** ,An Introduction to Measure Theory,Graduate Studies in Mathemat-ics,Vol126 AMS

<table>
<tr><td>Cours e No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures/ week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>8</td><td>MTH2 C08</td><td>Core</td><td>Topology</td><td>4</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Develop basic concepts of topological Spaces</td><td>Ap</td><td>(C,P)</td><td>15</td><td>1</td><td rowspan="5">2</td></tr>
<tr><td>CO 2</td><td colspan="5">Identify quotient spaces</td><td>Ap</td><td>(C,P)</td><td>15</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Explain spaces with special properties</td><td>U</td><td>(C,P)</td><td>15</td><td>2</td></tr>
<tr><td>CO 4</td><td colspan="5">Understand separation axioms</td><td>U</td><td>(C,P)</td><td>20</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Analyze Urysohn and Tietze characterization of normality</td><td>An</td><td>(C,P)</td><td>15</td><td>3</td></tr>
</table>

TEXT : JOSHI, K.D., INTRODUCTION TO GENERAL TOPOLOGY (Revised Edn.),New Age International(P) Ltd., New Delhi, 1983.

Module 1

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]

Module 2

MakingFunctionsContinuous,QuotientSpaces,SpaceswithSpecialPrope rties[Chapter5Section4andChapter6]

Module 3

SeparationAxioms:HierarchyofSeparationAxioms,CompactnessandSe parationAxioms, TheUrysohn Characterization of Normality, TietzeCharacterisation of Normality. [Chapter7:Sections1to3andSection4(uptoandincluding4.6)]

References

[1] **M.A. Armstrong**: Basic Topology; Springer- VerlagNew York;1983

[2] **J. Dugundji**: Topology; Prentice Hall of India;1975

[3] **M. Gemignani**: Elementary Topology; Addison Wesley Pub Co Reading Mass;1971

[4] **M.G. Murdeshwar**: General Topology(2nd Edn.); Wiley Eastern Ltd;1990

[5] **G.F.Simmons**:IntroductiontoTopologyandModernAnalysis;McGraw-HillInter- national Student Edn.;1963

[6] **S. Willard**: General Topology; Addison Wesley Pub Co., Reading Mass;1976

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
9	**MTH2 C09**	**Core**	**ODE & calculus of variations**	**4**	**5**					
CO	**CO Statement**									
CO 1	Create concepts of power series solutions					Cr	(C,P)	25	1	3
CO 2	Explain special functions of mathematical physics					U	(C,P)	10	2	
CO 3	Develop idea of systems of first order equation					U	(C,P)	10	2	
CO 4	Analyze non-linear equations					An	(C,P)	10	3	
CO 5	Demonstrate boundary value problems and related theorems					U	(C,P)	25	3	

TEXT : SIMMONS, G.F., DIFFERENTIAL EQUATIONS WITH APPLICATIONS AND HISTORICAL NOTES(3rd Edn.), NewDelhi, 1974.

Module 1

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]

Module 2

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]

Module 3

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.BirkhoffandG.C.Rota**:OrdinaryDifferentialEquations(3rdEdn.);Edn.Wiley & Sons;1978

[2] **W.E. Boyce and R.C. Diprima**: Elementary Differential Equations andboundary value problems(2nd Edn.); John Wiley & Sons, NY;1969

[3] **A. Chakrabarti**: Elements of ordinary Differential Equations and specialfunctions;Wiley Eastern Ltd., New Delhi; 1990

[4] **E.A. Coddington**: An Introduction to Ordinary Differential Equtions; PrinticeHall of India, New Delhi;1974

[5] **R.CourantandD.Hilbert**:MethodsofMathematicalPhysics-volI;WileyEastern Reprint;1975

[6] **P. Hartman**: Ordinary Differential Equations; John Wiley & Sons;1964

[7]L.S.Pontriyagin:AcourseinordinaryDifferentialEquationsHindustanPub.Corpo- ration, Delhi;1967

[8] **I. Sneddon**: Elements of Partial Differential Equations; McGraw-Hill International Edn.; 1957

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>10</td><td>MTH2 C10</td><td>Core</td><td>Operations Research</td><td>4</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Identify convex functions</td><td>Ap</td><td>(C,P)</td><td>15</td><td>1</td><td rowspan="5">3</td></tr>
<tr><td>CO 2</td><td colspan="5">Understand modeling and solving of linear programming problems</td><td>U</td><td>(C,P)</td><td>15</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Interpret modeling and solving of integer programming problems</td><td>U</td><td>(C,P)</td><td>15</td><td>3</td></tr>
<tr><td>CO 4</td><td colspan="5">Develop concepts of flow and potential in networks</td><td>Ap</td><td>(C,P)</td><td>15</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Explain theory of games</td><td>U</td><td>(C,P)</td><td>20</td><td>6</td></tr>
</table>

TEXT : K.V. MITAL; C. MOHAN., OPTIMIZATION METHODS IN OPERATIONSRESEARCH AND SYSTEMS ANALYSIS(3rd. Edn.), New Age International(P) Ltd., 1996.

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

Module 1

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

Module 2

LinearProgramming(contd.);TransportationProblem[Chapter3:Sections18to20, 22;Chapter4Sections1to11,13fromthetext]

Module 3

Integer Programming; Sensitivity Analysis [Chapter 6: Sections 1 to 9;Chapter 7

Sections1to10fromthetext]FlowandPotentialinNetworks;TheoryofGames[Chapter 5:Sections1to4,67;Chapter12:allSections]

References

[1] **R.L. Ackoffand M.W. Sasioni**: Fundamentals of Operations Research; Wiley Eastern Ltd. New Delhi;1991

[2] **C.S.Beightler,D.T.PhiliphsandD.J.Wilde**:Foundationsofoptimization (2nd Edn.);PrenticeHallofIndia,Delhi;1979

[3] **G. Hadley**: Linear Programming; Addison-Wesley Pub Co Reading, Mass;1975

[4] **G. Hadley**: Non-linear and Dynamic Programming; Wiley Eastern Pub Co.Reading,Mass; 1964

[5] **H.S. Kasana and K.D. Kumar**: Introductory Operations Research- Theory and Applications; Springer-Verlag;2003

[6] **R. Panneerselvam**: Operations Research; PHI, New Delhi(Fifth printing);2004

[7] **A. Ravindran, D.T. Philips and J.J. Solberg**: Operations Research- Principles andPractices(2ndEdn.);JohnWiley&Sons;2000

[8] **.Strang**: Linear Algebra and Its Applications(4th Edn.); Cengage Learning;2006

[9] **Hamdy A. Taha**: Operations Research- An Introduction(4th Edn.); Macmillan Pub Co. Delhi;1989

<table>
<tr><td>Course</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No.of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KL</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>PCC 1</td><td>MTH2 A02</td><td>Professional Competency Course</td><td>TECHNICA LWRITING WITH LATEX</td><td>4</td><td>0</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Understand the basic concept of LATEX</td><td>U</td><td>(C,P)</td><td>6</td><td rowspan="3">4</td></tr>
<tr><td>CO 2</td><td colspan="5">Plan to prepare a research paper with LATEX</td><td>Ap</td><td>(C,P)</td><td>6</td></tr>
<tr><td>CO 3</td><td colspan="5">Develop a beamer presentation</td><td>Ap</td><td>(C,P)</td><td>6</td></tr>
</table>

1. Installation of the software LATEX
2. Understanding LATEXcompilation
3. Basic Syntex, Writing equations, Matrix,Tables

4. Page Layout: Titles, Abstract, Chapters, Sections, Equation references, citation.
5. List makingenvironments
6. Table of contents, Generating newcommands

7. Figurehandling,numbering,Listoffigures,Listoftables,Generating bibliographyandindex

8. Beamerpresentation

9. Pstricks:drawingsimplepictures,Functionplotting,drawingpictureswithnodes

10. Tikz:drawing simple pictures, Function plotting, drawing pictures withnodes

References

[1] **L.Lamport**:ADocumentPreparationSystem,User'sGuideandReferenceM

anual, Addison-Wesley, New York, second edition,1994.

[2] **M.R.C.vanDongen**:LATEXandFriends,Springer-VerlagBerlinHeidelberg2012.

[3] **StefanKottwitz**:LATEXCookbook,PacktPublishing2015.

[4] **DavidF.GriffthsandDesmondJ.Higham**:LearningLATEX(secondedition), Siam2016.

[5] **GeorgeGratzer**:PracticalLATEX,Springer2015.

[6] **W. Snow**: TEX for the Beginner. Addison-Wesley, Reading,1992

[7] **D. E. Knuth**:TheTEXBook. Addison-Wesley, Reading, second edition,1986

[8] **M.Goossens,F.Mittelbach,andA.Samarin**:TheLATEXCompanion.Addison- Wesley, Reading, MA, second edition,2000.

[9] **M.GoossensandS.Rahtz**:TheLATEXWebCompanion:IntegratingTEX,HTML, andXML.Addison-WesleySeriesonToolsandTechniquesforComputerTypesetting. Addison-Wesley, Reading, MA,1999.

[10] **M.Goossens,S.Rahtz,andF.Mittelbach**:TheLATEXGraphicsCompanion: IllustratingDocumentswithTEXandPostScript.Addison-WesleySeriesonToolsand Techniques for Computer Typesetting. Addison-Wesley, New York, 1997

<table>
<tr><td>Course</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No.of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>PCC 2</td><td>MTH2A03</td><td>Professional Competency Course</td><td>PROGRAMMING WITH SCILAB</td><td>4</td><td>0</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Understand the basic Concepts of SCILAB</td><td>U</td><td>C</td><td>6</td><td rowspan="3">4</td></tr>
<tr><td>CO 2</td><td colspan="5">Develop 2-D & 3-D Graphics</td><td>Ap</td><td>(C,P)</td><td>6</td></tr>
<tr><td>CO 3</td><td colspan="5">Analyze Mathematical Problems with SCILAB</td><td>An</td><td>(C,P)</td><td>6</td></tr>
</table>

1. Installation of thesoftwareScilab.
2. Basic syntax, Mathematical Operators, Predefined constants, Built in functions.
3. Complex numbers, Polynomials, Vectors, Matrix. Handling these datastructuresusing built in functions
4. Programming
   a) Functions(b)Lo
   ops
   (c)Conditional statements
   (d)Handling .sci files
5. Installation of additional packages e.g. “optimization”
6. Graphicshandling
   (a) 2D,3D
   (b) Generating.jpgfiles
   (c)Function plotting

(d)Dataplotting

7. Applications

(a) NumericalLinearAlgebra(Solvinglinearequations,eigenvaluesetc.)

(b) Numerical Analysis: iterativemethods

(c)ODE: plotting solution curves

References

[1] **ClaudeGomez,CareyBunksJean-PhilippeChancelierFranoisDelebecqueMaurieeGoursatRamineNikoukhahSergeSteer**: EngineeringandScientific Computing with Scilab, Springer-Science, LLC,1998.

[2] **Sandeep Nagar**: Introduction to ScilabFor Engineers and Scientists, Apress,2017

Course No	Code	Course Category	Name of the course	No.of Credits	No. Of hours of Lectures /week	CL	KC	PO	PSO
PCC 3	**MTH 2A04**	**Professional Competency Course**	**SCIENTIFIC PROGRAMMING WITH PYTHON**	**4**	**0**				
CO	**CO Statement**								
CO 1	Explain basics of Python programming					U	C	6	4
CO 2	Apply Python programming in numerical analysis					Ap	(C,P)	6	
CO 3	Apply Python programming in Linear algebra					Ap	(C,P)	6	

1. LiteralConstants,Numbers,Strings,Variables,Identifier,Datatypes
2. Operators, Operator Precedence,Expressions
3. Control flow: If, while, for, break, continuestatements
4. Functions: Defining a function, function parameters, local variables, default argu- ments, keywords, return statement,Doc-strings
5. Modules:usingsystemmodules,importstatements,creatingmodules

6.Data Structures: Lists, tuples,sequences.

7. Writing a pythonscript
8. Files:Inputandoutputusingfileandpicklemodule
9. Exceptions: Errors, Try-except statement, raising exceptions, try-finally statement
10. RootsofNonlinearEquations:EvaluationofPolynomials,Bisectio nmethod,Newton-Raphson Method, Complex roots by Bairstow method.
11. Direct Solution of Linear Equations: Solution by elimination, Gauss Elimination method, Gauss Elimination with Pivoting, Triangular Factorisationmethod
12. IterativeSolutionofLinearEquations:JacobiIterationmethod,Gauss-

Seidelmethod.

13. CurveFitting-Interpolation:LagrangeInterpolationPolynomial,NewtonInterpolation Polynomial, Divided Difference Table, Interpolation with Equidistant points.

14. Numerical Differentiation: Differentiating Continuous functions, Differentiating Tab- ulatedfunctions.

15. Numerical Integration: Trapezoidal Rule, Simpsons 1/3rule.

16. NumericalSolutionofOrdinaryDifferentialEquations:EulersMethod,Rung-Kutta method (Order4)

17. Eigenvalue problems: Polynomial Method, Power method

References

[1] **Swaroop C H:** , A Byte ofPython.
[2] **AmitSaha:** ,Doing Math with Python, No Starch Press,2015.
[3] **SD Conte and Carl De Boor :** Elementary Numerical Analysis (An algorithmic approach) 3rd edition, McGraw-Hill, NewDelhi
[4] **K.SankaraRao:**NumericalMethodsforScientistsandEngineersPrenticeHallof India, NewDelhi.
[5] **Carl E Froberg :** Introduction to Numerical Analysis, Addison Wesley Pub Co,2nd Edition
[6] **KnuthD.E.:**TheArtofComputerProgramming:FundamentalAlgorithms(Volume I), Addison Wesley, Narosa Publication, NewDelhi.
[7] Python Programming, wikibooks contributors Programming Python, Mark Lutz,
[8]Python 3 Object Oriented Programming, Dusty Philips, PACKT Open sourcePublishing
[9]Python Programming Fundamentals, Kent D Lee, Springer
[10]Learning to Program Using Python, Cody Jackson, Kindle Edition
[11]Online reading http://pythonbooks.revolunet.com/

SEMESTER III

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>1</td><td>MTH 3C11</td><td>Core</td><td>Multivariable Calculus & Geometry</td><td>4</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Develop an idea of functions of several variables</td><td>Ap</td><td>(C,P)</td><td>15</td><td>1</td><td rowspan="5">1</td></tr>
<tr><td>CO 2</td><td colspan="5">Understand contraction principle and inverse function theorem</td><td>U</td><td>(C,P)</td><td>15</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Analyze characterization of curves</td><td>An</td><td>(C,P)</td><td>20</td><td>2</td></tr>
<tr><td>CO 4</td><td colspan="5">Interpret characterization of surfaces</td><td>U</td><td>(C,P)</td><td>15</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Identify different curvatures</td><td>Ap</td><td>(C,P)</td><td>15</td><td>6</td></tr>
</table>

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

TEXT2: ANDREW PRESSLEY, ELEMENTARY DIFFERENTIAL GEOMETRY(2ndEdn.), Springer-Verlag, 2010.

Module 1

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

Module 2

What is a curve? Arc-length, Reparametrization, Closed curves, 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 3

Levelsurfaces,Ruledsurfacesandsurfacesofrevolution,Applicationsoftheinversefunc-
tiontheorem,Lengthsofcurvesonsurfaces,EquiarealmapsandatheoremofArchimedes, The second fundamental form, The Gauss and Weingarten maps, Normal and geodesic curvatures. Gaussian and mean curvatures, Principal curvatures of a surface.

[Chapter5 Sections 1 , 3 & 6, Chapter 6 Sections 1 and 4(up to and including 6.4.3) Chapter 7 Sections 1 – 3, Chapter 8 Sections 1 – 2 from Text - 2]

References

[1] **M. P. do Carmo**: Differential Geometry of Curves andSurfaces;

[2] **W. Klingenberg**: A course in DifferentialGeometry;

[3] **J. R. Munkres**: Analysis on Manifolds; Westview Press;1997

[4] **C. C. Pugh**: Real Mathematical Analysis, Springer;2010

[5] **M. Spivak:** A Comprehensive Introduction to Differential Geometry-Vol. I; Publish or Perish, Boston; 1970

[6] **M. Spivak**: Calculus on Manifolds; Westview Press;1971

[7] **V.A. Zorich**: Mathematical Analysis-I; Springer;2008

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
2	**MTH3 C12**	**Core**	**Complex Analysis**	**4**	**5**					
CO	CO Statement									
CO 1	Develop concepts of conformality					Ap	(C,P)	25	1	
CO 2	Explain fundamental theorem and Cauchy's Integral formula					U	(C,P)	15	2	
CO 3	Create an idea of analytical functions and related theorems					Cr	(C,P)	10	3	2
CO 4	Understand power series expansion					U	(C,P)	20	3	
CO 5	Understand periodic functions					U	(C,P)	10	3	

TEXT : JOHN B. CONWAY, FUNCTIONS OF ONE COMPLEX VARIABLE(2nd Edn.);Springer International Student Edition; 1992

Module 1

The extended plane and its spherical representation, Power series, Analyticfunctions,Analyticfunctionsasmappings,Mobiustransformations,Riemann-Stieltijesintegrals
[Chapt.ISection6;,Chapt.IIISections1,2and3;ChapterIVSection1]

Module 2

Power series representation of analytic functions, Zeros of an analytic function,The indexofaclosedcurve,Cauchy’sTheoremandIntegral Formula,Thehomotopicversion ofCauchysTheoremandsimpleconnectivity,Countingzeros;theOpenMappingTheorem and GoursatsTheorem.

Module 3

The classification of singularities, Residues, The Argument Principle and TheMaximum Principle, Schwarz's Lemma, Convex functions and Hadamards three circles theorem [Chapt.V:Sections1,2,3;ChapterVISections1,2,3]

References

[1] **H.Cartan**:ElementaryTheoryofanalyticfunctionsofoneorseveralvariables;Addison - Wesley Pub. Co.; 1973

[2] **T.W. Gamelin**: Complex Analysis; Springer-Verlag, NY Inc.;2001

[3] **T.O. Moore and E.H. Hadlock**: Complex Analysis, Series in PureMathematics-Vol. 9; World Scientific; 1991

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

[5] **R. Remmert**: Theory of Complex Functions; UTM , Springer-Verlag, NY; 1991

[6] **W. Rudin**: Real and Complex Analysis(3rd Edn.); McGraw - Hill International Editions;1987

[7] **H. Sliverman**: Complex Variables; Houghton Mifflin Co. Boston;1975

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
3	**MTH3 C13**	**Core**	**Functional Analysis**	**4**	**5**					
CO	CO Statement									
CO 1	Explain of Matrix Spaces					U	(C,P)	25	1	
CO 2	Understand Fourier Seies and Integrals					U	(C,P)	20	1	
CO 3	Understand Banach Spaces and related theorems					U	(C,P)	15	2	4
CO 4	Illustrate Closed Graph and Open Mapping theorem					U	(C,P)	10	3	
CO 5	Analyse Inner Product Spaces					An	(C,P)	10	3	

TEXT :YULI EIDELMAN, VITALI MILMAN & ANTONIS TSOLOMITIS; FUNC- TIONAL ANALYSIS AN INTRODUCTION; AMS, Providence, Rhode Island, 2004

Module 1

LinearSpaces;normedspaces;firstexamples:Linearspaces,Normedspaces;firs texamples, Holder'sinequality,Minkowski'sinequality,Topologicalandgeometricnotions ,Quotient normed space, Completeness;completion. [Chapter 1 Sections 1.1-1.5]

Module 2

Hilbertspaces:Basicnotions;firstexamples,Cauchy-SchwartzinequalityandHilbertian norm, Bessels inequality,Completesystems, Gram-Schmidt orthogonalization procedure, orthogonal bases, Parseval' identity; Projection; orthogonal decompositions; Separable case, The distance from a point to a convex set, Orthogonal decomposition; linear functionals; Linear functionals in a general linear space,Bounded linear functionals, Bounded linear functionals in a Hilbert space, An example of a non-separable Hilbert space. [Chapter 2; Sections 2.1-2.3(omit Proposition 2.1.15)]

Module 3

The dual space; The Hahn Banach Theorem and its first consequences, corollariesof the Hahn Banach theorem, Examples of dual spaces. Bounded linear Operators; Completenessofthespaceofboundedlinearoperators,Examplesoflinearoperators,Compact operators, Compact sets, The space of compact operators, Dual operators ,Operators of finite rank, Compactness of the integral operators in L2, Convergence in the space of boundedoperators,Invertibleoperators[Chapter3;Sections3.1,3.2;Chapter4;Sections 4.1-4.7]

References

[1] **B. V. Limaye**: Functional Analysis, New Age International Ltd, New Delhi,1996.

[2] **G.BachmanandL.Narici**:FunctionalAnalysis;AcademicPress,NY;1970

[3] **J. B. Conway**: Functional Analysis; Narosa Pub House, New Delhi;1978

[4] **J. Dieudonne**: Foundations of Modern analysis; Academic Press;1969

[5] **W. Dunford and J. Schwartz**: Linear Operators - Part 1: General Theory; John Wiley & Sons;1958

[6] **KolmogorovandS.V.Fomin**:ElementsoftheTheoryofFunctionsandFunctional Analysis(Englishtranslation);GraylockPress,RochasterNY;1972

[7] **E.Kreyszig**: IntroductoryFunctionalAnalysiswithapplications;JohnWiley&Sons; 1978

[8] **F. Riesz and B. Nagy**:Functional analysis; Frederick Unger NY; 1955

[9] **W. Rudin**: Functional Analysis; TMH edition;1978

[10] **W. Rudin**: Real and Complex Analysis(3rd Edn.); McGraw-Hill;1987

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
4	**MTH3 C14**	**Core**	**PDE & Integral Equations**	**4**	**5**					
CO	CO Statement									
CO 1	Summarize first order partial differential equations					U	(C,P)	15	1	3
CO 2	Develop methods of solving first order partial differential equations					Ap	(C,P)	15	2	
CO 3	Apply second order partial differential equations					Ap	(C,P)	15	3	
CO 4	Identify methods of solving second order partial differential equations					Ap	(C,P)	10	3	
CO 5	Demonstrate integral equations					U	(C,P)	25	3	

TEXT 1: AN INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS, YEHUDAPINCHOVER AND JACOB RUBINSTEIN, Cambridge University Press

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

Module 1

First-orderequations: Introduction,Quasilinearequations,Themethodofcharacter-istics, Examples of the characteristics method, The existence and uniqueness theorem, The Lagrange method, Conservation laws and shock waves, The eikonal equation, Gen- eral nonlinearequations

Second-order linear equations in two indenpendentvariables: Introduction, Clas-sification,Canonicalformofhyperbolicequations,Canonicalformofparabolicequations, Canonical form of ellipticequations

Theone-dimensionalwaveequation: Introduction,Canonicalformandgeneralsolution,TheCauchyproblemandd'Alembertsformula,Domainofdependenceandr egionof influence,TheCauchyproblemforthenonhomogeneouswaveequation[Chapter 2,3and4 from Text1]

Module 2

Themethodofseparationofvariables: Introduction,Heatequation:homogeneous boundarycondition,Separationofvariablesforthewaveequation,Separationofvariable s fornonhomogeneousequations,Theenergymethodanduniqueness,Furtherapplicatio ns of the heatequation

Elliptic equations: Introduction, Basic properties of elliptic problems, The maximum principle,Applicationsofthemaximumprinciple,Greensidentities,Themaximumprin - ciplefortheheatequation,Separationofvariablesforellipticproblems,Poissonsformul a [Chapter 5 and 7 fromText 1]

Module 3

Integral Equations: Introduction, Relations between differential and integral equations, TheGreen'sfunctions,Fredholomequationswithseparablekernels,Illustrativeexampl es, Hilbert-SchmidtTheory,IterativemethodsforsolvingEquationsofthesecondkind.The Newmann Series, Fredholm Theory [Sections 3.1 3.3, 3.6 3.11 from the Text2]

References

[1] **AmaranathT.**:Partial Differential Equations, Narosa, New Delhi,1997.
[2] **A. Chakrabarti**: Elements of ordinary Differential Equations and specialfunctions; Wiley Eastern Ltd, New Delhi; 1990
[3] **E.A. Coddington**: An Introduction to Ordinary Differential EqutionsPrintice Hall of India ,New Delhi;1974
[4] **R.CourantandD.Hilbert**:MethodsofMathematicalPhysics-VolI;WileyEastern Reprint;1975

[5] **P. Hartman**: Ordinary Differential Equations; John Wiley & Sons;1964
[6] **F. John**: Partial Differential Equations; Narosa Pub House New Delhi;1986
[7] **PhoolanPrasadRenukaRavindran**:PartialDifferentialEquations;Wiley Eastern Ltd, New Delhi;1985

[8] **L.S.Pontriyagin**:AcourseinordinaryDifferentialEquations;HindustanPub .Cor- poration, Delhi;1967

[9] **I. Sneddon**: Elements of Partial Differential Equations; McGraw-Hill International Edn.;195

ELECTIVE 1 IN SEMESTER III

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures/ week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>E 01</td><td>MTH 3E01</td><td>Elective</td><td>Coding theory</td><td>3</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Discuss strong concept of error detection, correction and their effects</td><td>Cr</td><td>(C,P)</td><td>25</td><td>2</td><td rowspan="5">3</td></tr>
<tr><td>CO 2</td><td colspan="5">Demonstrate different types of codes</td><td>U</td><td>(C,P)</td><td>20</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Interpret cyclic linear codes and dual cyclic codes</td><td>U</td><td>(C,P)</td><td>15</td><td>3</td></tr>
<tr><td>CO 4</td><td colspan="5">Create cyclic hamming codes</td><td>Cr</td><td>(C,P)</td><td>10</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Develop decoding 2 error correcting BCH linear codes</td><td>Ap</td><td>(C,P)</td><td>10</td><td>3</td></tr>
</table>

TEXT : D.J. Hoffman, Coding Theory : The Essentials, Mareel Dekker Inc, 1991

Module 1

Detecting and correcting error patterns, Information rate, the effects of error detec- tion and correction, finding the most likely code word transmitted, weight and distance, MLD, Error detecting and correcting codes. linear codes, bases for $C =< S >$and $C^{\perp}$, generatingandparitycheekmatrices,equivalentcodes,distanceoflinearcode,MLDfor alinearcode,reliabilityofIMLDforlinearcodes[Chapter1&Chapter2]

Module 2

Perfect codes, hamming code, Extended code, Golay code and extended Golay code, Red Hulles codes[Chapter 3: Sections 1 to 8]

Module 3

Cyclic linear codes, polynomial encoding and decoding, dual cyclic codes, BCH linear codes,CyclicHammingcode,Decoding2errorcorrectingBCHcodes[Chapter4 andAp- pendixAofthechapter,Chapter5]

References

[1] **E.R. Berlekamp:** Algebraic coding theory, McGraw Hill,1968

[2] **P.J. Cameron and J.H. Van Lint:** Fundamentals of Wavelets Theory Algorithms and Applications, John Wiley and Sons, Newyork. ,1999.

[3] **Yves Nievergelt:** Graphs, codes and designs,CUP.

[4] **H. Hill :** A first Course in Coding Theory, OUP, 1986

ELECTIVE 2 IN SEMESTER III

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
E 02	**MTH3 E02**	**Elective**	**Cryptography**	**3**	**5**					
CO	CO Statement									
CO 1	Develop knowledge in classical cryptography					Ap	(C,P)	15	2	4
CO 2	Discuss simple cryptosystems					Cr	(C,P)	20	2	
CO 3	Analyze different ciphers					An	(C,P)	15	3	
CO 4	Create block ciphers					Cr	(C,P)	20	3	
CO 5	Understand cryptographic hash functions					U	(C,P)	10	6	

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

Module 1

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

Module 2

Shannons Theory:- Elementary Probability Theory, Perfect Secrecy, Entropy, Huff- man Encodings, Properties of Entropy, Spurious Keys and Unicity Distance, Product Cryptosystem.

Module 3

Block Ciphers: Substitution Permutation Networks, Linear Cryptanalysis, Differen- tialCryptanalysis , 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: Sections3.1,3.2,3.3(3.3.1to3.3.3),Sect.3.4,Sect.3.5(3.5.1,3.5.2),Sect.3.6(3.6.1,3.6.2);

Chapter4:Sections4.1,4.2(4.2.1to4.2.3),Section4.3(4.3.1,4.3.2),Section4.4(4.4.1,4.4.2),Section 4.5 (4.5.1, 4.5.2)]

References

[1] **JeffreyHoffstein:**JillPipher,JosephH.Silverman,AnIntroductiontoMathemat- ical Cryptography, Springer InternationalEdition.

[2] **H. Deffs& H. Knebl:** Introduction to Cryptography, Springer Verlag,2002.

[3] **Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone:** Handbook ofAppliedCryptography,CRCPress,1996.

[4] **William Stallings:** Cryptography and Network Security Principles and Practice, Third Edition, Prentice-hall India,2003.

ELECTIVE 3 IN SEMESTER III

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>E 03</td><td>MTH 3E03</td><td>Elective</td><td>Measure & Integration</td><td>3</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Explain measurability and their properties</td><td>U</td><td>(C,P)</td><td>15</td><td>2</td><td rowspan="5">2</td></tr>
<tr><td>CO 2</td><td colspan="5">Understand integration of complex functions using concepts of measure</td><td>U</td><td>(C,P)</td><td>10</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Analyze Riesz representation theorem</td><td>An</td><td>(C,P)</td><td>15</td><td>1</td></tr>
<tr><td>CO 4</td><td colspan="5">Create knowledge in Lebesgue measures and their completion</td><td>Cr</td><td>(C,P)</td><td>20</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Develop non measurable infinite set</td><td>Ap</td><td>(C,P)</td><td>20</td><td>3</td></tr>
</table>

TEXT : WALTER RUDIN, REAL AND COMPLEX ANALYSIS(3rd Edn.), Mc.Graw- Hill International Edn., New Delhi, 1987.

Module 1

The concept of measurability, Simple functions, Elementary properties of measures, Arithmeticin[0,infinity],IntegrationofPositiveFunctions,IntegrationofComplex Func- tions, The Role Played by Sets of Measure zero, Topological Preliminaries, The Riesz RepresentationTheorem.(Chap.1,Sections:1.2to1.41Chap.2,Sections:2.3to2.14)

Module 2

RegularityPropertiesofBorelMeasures,LebesgueMeasure,ContinuityProp ertiesof Measurable Functions.Total Variation, Absolute Continuity, Consequences of Radon - Nikodym Theorem. (Chap. 2, Sections : 2.15 to 2.25 Chap. 6, Sections : 6.1 to6.14)

Module 3

BoundedLinearFunctionalsonL^P,TheRieszRepresentationTheorem,Measurability on Cartesian Products, Product Measures, The FubiniTheorem, 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) ThirdEdition

[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

ELECTIVE 4 IN SEMESTER III

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
E04	**MTH 3E04**	**Elective**	**Probability Theory**	**3**	**5**					
CO	CO Statement									
CO 1	Understnd random variables and their probability distributions					U	(C,P)	15	1	2
CO 2	Explain moments and generating functions					U	(C,P)	10	1	
CO 3	Analyze multiple random variables					An	(C,P)	15	3	
CO 4	Identify covariance, correlation and moments.					Ap	(C,P)	15	3	
CO 5	Illustrate law of large numbers					U	(C,P)	25	3	

TEXT : An Introduction to Probability Theory and Statistics (Second Edition), By VijayK. Rohatgi and A.K. MD. EhsanesSaleh, John Wiley Sons Inc. New York

Module 1

RandomVariablesandTheirProbabilityDistributionsRandomVariables.Probability DistributionofarandomVariable.DiscreteandContinuousRandomVariables.Functions of a random Variable.Chapter 2 of Text.(Sections 2.1- 2.5) Moments and Generating Functions. Moments of a distribution Function. Generating Functions.Some Moment Inequalities.Chapter 3 of Text.(Sections 3.1-3.4)

Module 2

Multiple Random Variables.Multiple random Variables.Independent RandomVari- ables.Functions of several Random variables.Covariance, Correlation and Moments.Conditional Expectations Order statistics and their Distributions.Chapter 4 of Text.(Sections 4.1-4.7)

Module 3

Limit Theorems. Modes of Convergence.Weak law of Large Numbers.Strong Law of large Numbers.Limiting Moment Generating Functions.Central Limit Theorem.Chapter 6 of Text.(Sections 6.1-6.6)

References

[1] **B.R. Bhat:** MODERN PROBABILITY THEORY (Second Edn.) Wiley Eastern Lim- ited, Delhi(1988)

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

[3] **W.E.Feller:** An Introduction to Probability Theory and its Applications VolsI & II- JohnWiley&Sons,(1968)and(1971)

[4] **Rukmangadachari E.:** Probability and Statistics, Pearson(2012)

[5] **Robert V Hogg, Allen Craig & Joseph W McKean:** Introduction to Mathe- matical Statistics (Sixth Edn.), Pearson2005.

SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
1	**MTH 4C15**	**Core**	**Advanced Functional Analysis**	**4**	**5**					
CO	**CO Statement**									
CO 1	Explain Duals and Transposes					U	(C,P)	15	1	
CO 2	Understand Compact Linear map, Spectrum of Compact operator					U	(C,P)	15	2	4
CO 3	Explain Riesz Representation Theorem					U	(C,P)	10	3	
CO 4	Understand bounded operators and adjoints					U	(C,P)	15	3	
CO 5	Identify spectrum and numerical range					Ap	(C,P)	25	3	

Text: YULI EIDELMAN, VITALI MILMAN & ANTONIS TSOLOMITIS; FUNCTIONALANALYSIS AN INTRODUCTION; AMS, Providence, Rhode Island, 2004.

Module 1

Spectrum, Fredholm Theory of Compact operators; Classification of spectrum, Fred- holmTheoryofCompactoperators.Selfadjointoperators;Generalproperties,Selfadjoint compactoperators,spectraltheory,minimaxprinciple,Applicationstointegraloperators. [Chapter5;Sections5.1,5.2;Chapter6;Sections6.1,6.2]

Module 2

Order in the space of self-adjoint operators, properties of the ordering; Projection operators; properties of projection in linear spaces, Orthogonal projections. Functions of Operators spectraldecomposition;Spectraldecomposition,Themaininequality,Constructionofthe spectral integral, Hilbert Theorem[Chapter6; Sections6.3- 6.4, Chapter7, sections 7.1,7.2 up to and including statement of Theorem 7.2.1]

Module 3

The fundamental theorems and the basic methods; Auxiliary results, The Banach open mapping Theorem, The closed graph Theorem, The Banach- Steinhaus theorem, Bases in Banach spaces, Linear functionals;the Hahn Banach theorem, Separation of Convex sets. Banach Algebras; Preliminaries, Gelfand's theorem on maximal ideals[Chapter9 Sections9.1- 9.7; Chapter10, Sections10.1, 10.2]

References

[1] **B. V. Limaye**: Functional Analysis, New Age International Ltd, New Delhi,1996.

[2] **R. Bhatia:** Notes on Functional Analysis TRIM series, Hindustan BookAgency

[3] **KesavanS:** Functional Analysis TRIM series, Hindustan BookAgency

[4] **S David Promislow:** A First Course in Functional Analysis, John wiley& Sons, INC.,(2008)

[5] **Sunder V.S:** Functional Analysis TRIM Series, Hindustan BookAgency

[6] **George Bachman &LawrenceNarici:** Functional Analysis Academic Press, NY (1970)

[7] **KolmogorovandFominS.V:**ElementsoftheTheoryofFunctionsandFuncti onal Analysis.EnglishTranslation,Graylock,PressRochasterNY(1972)

[8] **W.DunfordandJ.Schwartz:**LinearOperatorsPart1,GeneralTheoryJohn Wiley& Sons(1958)

[9] **E.Kreyszig:**IntroductoryFunctionalAnalysiswithApplicationsJohnWiley &Sons (1978)

[10] **F. Riesz and B. Nagy:**Functional Analysis Frederick Unger NY (1955)

[11] **J.B.Conway:** Functional AnalysiNarosa Pub House New Delhi(1978)

[12] **Walter Rudin:** Functional Analysis TMH edition(1978)

[13] **Walter Rudin:** Introduction to Real and Complex Analysis TMH edition(1975)

[14] **J.Dieudonne:** Foundations of Modern Analysis Academic Press(1969)

[15]**YuliEidelman,VitaliMilmanandAntonisTsolomitis:**Functionalanalysi sAn Introduction,GraduateStudiesinMathematicsVol.66AmericanMathematic alSoci- ety2004.

ELECTIVE 1 IN SEMESTER IV

<table>
<tr><td>Course No</td><td>Code</td><td>Course Category</td><td>Name of the course</td><td>No. of Credits</td><td>No. Of hours of Lectures /week</td><td rowspan="3">CL</td><td rowspan="3">KC</td><td rowspan="3">Hrs</td><td rowspan="3">PO</td><td rowspan="3">PSO</td></tr>
<tr><td>E01</td><td>MTH 4E05</td><td>Elective</td><td>Advanced Complex Analysis</td><td>3</td><td>5</td></tr>
<tr><td>CO</td><td colspan="5">CO Statement</td></tr>
<tr><td>CO 1</td><td colspan="5">Analyze Mittag-Leffler theorem and Weierstrass theorem</td><td>An</td><td>(C,P)</td><td>20</td><td>1</td><td rowspan="5">4</td></tr>
<tr><td>CO 2</td><td colspan="5">Understand infinite products</td><td>U</td><td>C</td><td>20</td><td>2</td></tr>
<tr><td>CO 3</td><td colspan="5">Explain entire functions of finite order</td><td>U</td><td>(C,P)</td><td>15</td><td>2</td></tr>
<tr><td>CO 4</td><td colspan="5">Apply multiple valued functions in complex analysis</td><td>Ap</td><td>(C,P)</td><td>15</td><td>3</td></tr>
<tr><td>CO 5</td><td colspan="5">Demonstrate space of analytic and meromorphic functions</td><td>U</td><td>(C,P)</td><td>10</td><td>3</td></tr>
</table>

TEXT 1: JOHN B. CONWAY, FUNCTIONS OF ONE COMPLEX VARIABLE(2^{nd}Edn.), Springer International Student Edition, 1973

Module 1

The Space of continuous functions $C(tt, \Omega)$, Spaces of Analytic functions, Spaces of meromorphicfunctions,TheRiemannMappingtheorem,WeierstrassFactorizat ionThe- orem[Chapter. VII: Sections 1, 2, 3,4 and5]

Module 2

Factorization of the sine function, Gamma function, The Riemann Zeta function, Runge's theorem, Simpleconnectedness

[Chapt. VII: Sections 6, 7 and 8, Chapter VIII Sections 1 and 2]

Module 3

Mittage–Leffler's Theorem, Schwarz reflexion principle, Analytic continuation along a path, Monotromy theorem, Jensen's formula, The Genus and order of an entire func- tion, Statement of Hadamars factorization theorem [Chapt. VIII: Section 3, Chapter 9 sections1,2and3,Chapter11sections1,2,Section3StatementofHadamarsfactorization theoremonly]

References:

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

[2] **ConwayJ.B:**FunctionsofOneComplexVariable,NarosaPub.Co,NewDelhi(1973)

[3] **MooreT.O.&Hadlock E.H:**ComplexAnalysis,SeriesinPureMathematics-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] **RemmertR:**TheoryofComplexFunctions,UTM,Springer-verlag,NY,(1991)

ELECTIVE 2 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
E02	**MTH 4E06**	**Elective**	**Algebraic Number Theory**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand symmetric polynomials, modules and algebraic numbers					U	(C,P)	15	1	
CO 2	Explain ring of integers, quadratic fields and cyclotomic fields					U	(C,P)	10	2	1
CO 3	Illustrate different factorizations					U	(C,P)	25	2	
CO 4	Explain Minkowski theorem					U	(C,P)	15	3	
CO 5	Develop Fermats last thorem					Ap	(C,P)	15	3	

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

Module 1

Symmetric polynomials, Modules, Free abelian groups, Algebraic Numbers, Conju- gates 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 2

Historical background, Trivial Factorizations, Factorization into Irreducibles, Exam- ples of Nonunique Factorization into Irreducibles, Prime Factorization, Euclidean Do- mains, 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 3

Lattices, The Quotient Torus, Minkowski theorem, The Space Lst, The Class-Group AnExistenceTheorem,FinitenessoftheClass-Group,FactorizationofaRationalPrime, FermatsLast Theorem Some history, Elementary Considerations, Kummers Lemma, Kummers 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:**AlgebraicNumberTheory,AddisonWesleyPubCo.,Reading,Mass,

(1970)

[3]bfD.Marcus:NumberFields,Universitext,SpringerVerlag,NY,(1976)

[4]4 **T.I.FR. Pamphlet No: 4 :**Algebraic Number Theory (Bombay, 1966)

[5] **HarveyCohn:**AdvancedNumberTheory,DoverPublicationsInc.,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 UniversityPress.

[8] **Z.I.Borevich&I.R.Shafarevich:**NumberTheory,AcademicPress,NY1966.

[9] **Esmonde&RamMurthy:**ProblemsinAlgebraicNumberTheory,Springer Verlag2000.

ELECTIVE 3 IN SEMESTER IV

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Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
E03	**MTH 4E07**	**Elective**	**Algebraic Topology**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand geometric complexes and polyhedra					U	(C,P)	15	1	2
CO 2	Explain simplicial homology groups					U	(C,P)	10	2	
CO 3	Explain simplicial approximations					U	(C,P)	15	3	
CO 4	Understyand Brouwer fixed point theorem and related results					U	(C,P)	15	3	
CO 5	Develop homotopic paths and covering homotopy property					Ap	(C,P)	25	3	

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

(Pre requisites : Fundamentals of group theory and Topology)

Module 1

GeometricComplexesandPolyhedra:Introduction.Examples,Geometric Complexes andPolyhedra,Orientationofgeometriccomplexes.SimplicialHomologyGroups:Chains, cycles,Boundariesandhomologygroups,Examplesofhomologygroups;The structureof homology groups; [Chapter 1: Sections 1.1 to 1.4; Chapter 2: Sections 2.1 to 2.3 from the text]

Module 2

Simplicial Homology Groups (Contd.): The Euler Poincare's Theorem; PseudomanifoldsandthehomologygroupsofS_n.SimplicialApproximation: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 thetext]

Module 3

TheFundamentalGroup:Introduction,HomotopicPathsandtheFundamentalGroup, The Covering Homotopy Property for S1, Examples of Fundamental Groups. [Chapter 4: Sections4.1to4.4fromthetext]

References

[1] **Eilenberg S, Steenrod N.**: Foundations of Algebraic Topology; PrincetonUniv.Press; 1952

[2] **S.T. Hu**: Homology Theory; Holden-Day;1965

[3] **Massey W.S.**: Algebraic Topology : An Introduction; Springer VerlagNY;1977

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

ELECTIVE 4 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
E04	**MTH 4E08**	**Elective**	**Commutative Algebra**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand properties of rings and ideals					U	(C,P)	15	1	
CO 2	Explain modules					U	(C,P)	10	1	
CO 3	Identify modules of fractions					Ap	(C,P)	25	2	1
CO 4	Interpret integral dependence and valuation					U	(C,P)	15	3	
CO 5	Compare Noetherian rings and Artinian rings					U	(C,P)	15	3	

TEXT : ATIYAH M.F., MACKONALD I. G., INTRODUCTION TO COMMUTATIVEALGEBRA, Addison Wesley, NY, 1969.

Module 1

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

Module 2

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

Module 3

IntegralDependenceandValuation,Chainconditions,Noetherianrings,Artinianrings [ChaptersV,VI,VII&VIIIfromthetext]

References

[1] **N. Bourbaki**: Commutative Algebra; Paris - Hermann;1961

[2] **D. Burton**: A First Course in Rings and Idials; Addison -Wesley; 1970

[3] **N. S. Gopalakrishnan**: Commutative Algebra; Oxonian Press;1984

[4] **T.W. Hungerford**: Algebra; Springer VerlagGTM 73(4th Printing);1987

[5] **D. G. Northcott**: Ideal Theory; Cambridge University Press;1953

[6] **O.Zariski,P.Samuel**:CommutativeAlgebra-Vols.I&II;VanNostrand,Princeton; 1960

ELECTIVE 5 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
E05	**MTH 4E09**	**Elective**	**Differential Geometry**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand concepts of graphs and level sets					U	(C,P)	15	1	
CO 2	Explain vector fields on surfaces					U	(C,P)	10	1	
CO 3	Analyze geodesics, parallel transport and Weingarten map.					An	(C,P)	25	2	3
CO 4	Explain properties of surfaces-curvature, local equivalence.					U	(C,P)	15	3	
CO 5	Identify different types of surfaces					Ap	(C,P)	15	3	

TEXT : J.A.THORPE : ELEMENTARY TOPICS IN DIFFERENTIAL GEOMETRY

Module 1

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 2

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 3

CurvatureofSurfaces,ParametrizedSurfaces,LocalEquivalenceofSurfaces andParametrized Surfaces. [Chapters 12,14,15 from thetext]

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.GrillemanandA.Pollack:**DifferentialTopology,PrenticeHallIncEngle wood Cliffs NJ(1974)

[4] **B. O'Neil :** Elementary Differential Geometry, Academic Press NY(1966)

[5] **M.Spivak:**AComprehensiveIntroductiontoDifferential,Geometry,(Volu mes1to 5),PublishorPerish,Boston(1970,75)

[6] **R. Millmen and G. Parker :** Elements of Differential Geometry, Prentice Hall Inc Englewood Cliffs NJ(1977)

[7] **I.SingerandJ.A.Thorpe:**LectureNotesonElementaryTopologyandGeom etry, UTM, Springer Verlag, NY(1967)

ELECTIVE 6 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
E06	**MTH4 E10**	**Elective**	**Fluid Dynamics**	**3**	**5**					
CO	**CO Statement**									
CO 1	Analyze equations of motion					An	(C,P)	15	1	4
CO 2	Create two dimensional motion					Cr	(C,P)	10	1	
CO 3	Explain streaming motions and aerofoils					U	(C,P)	25	2	
CO 4	Interpret sources and sinks					U	(C,P)	15	3	
CO 5	Understand Stokes' stream functions					U	(C,P)	15	3	

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

Module 1

EQUATIONS OF MOTION : Differentiation w.r.t. the time, The equation ofcontinu-ityBoundarycondition(KinematicalandPhysical),Rateofchangeoflinearmomentum, Theequationofmotionofaninvicidfluid,Conservativeforces,Steadymotion,Theenergy equation,Rateofchangeofcirculation,Vortexmotion,Permanenceofvorticity,Pressure equation, Connectivity, Acyclic and cyclic irrotational motion, Kinetic energy of liquid, Kelvins minimum energy theorem. TWO-DIMENSIONAL MOTION : Motion in two-dimensions,Intrinsicexpressionforthevorticity;Therateofchangeofvorticity;Intrinsic equationsofsteadymotion;Streamfunction;Velocityderivedfromthestream-

function;
Rankine'smethod;Thestreamfunctionofauniformstream;Vectorexpressionforvelocity and vorticity; Equation satisfied by stream function; The pressure equation; Stagnation points;Thevelocitypotentialofaliquid;Theequationsatisfiedbythevelocitypotential. [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 2

STREAMINGMOTIONS:Complexpotential;Thecomplexvelocitystagnation 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,Rigidboundariesandthecircletheorem,TheJoukowskitransformation, The- orem of Blasius. AEROFOILS: Circulation about a circular cylinder, The circulation betweenconcentriccylinders,Streamingandcirculationforacircularcylinder,Theaero- foil,FurtherinvestigationsoftheJoukowskitransformationGeometricalconstructionfor thetransformation,ThetheoremofKuttaandJoukowski.[ChaperVI:Sections6.0,6.01, 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 3

SOURCESANDSINKS:Twodimensionalsources,Thecomplexpotentialforasimple source,Combinationofsourcesandstreams,SourceandsinkofequalstrengthsDoublet, 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 aplane, SourcesinconformaltransformationSourceinananglebetweentwowalls,Sourceoutside acircularcylinder,Theforceexertedonacircularcylinderbyasource.STKOKES' STREAM FUNCTION: Axisymmetrical motions Stokes stream function, Simple source,Uniformstream,Sourceinauniformstream,Finitelinesource,Airshipforms, Sourceand equalsink-

Doublet;Rankin'ssolids.[ChapterVIII.Sections8.10,8.12,8.20,8.22,8.23, 8.30,8.40,8.41,8.42,8.43,8.50,8.51,8.60,8.61,8.62.ChapterXVI.Sections16.0,16.1, 16.20, 16.22, 16.23, 16.24, 16.25, 16.26, 16.27]

References

[1] **VonMisesandK.O.Friedrichs:**FluidDynamics,SpringerInternationalEdition . Reprint,(1988)
[2] **James EA John :**Introduction to Fluid Mechanics (2nd Edn.), Prentice Hall of India,Delhi,(1983).
[3] **Chorlten :** Text Book of Fluid Dynamics, CBS Publishers, Delhi1985
[4] **A. R. Patterson :** A First Course in Fluid Dynamics, Cambridge University Press 1987

ELECTIVE 7 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
E07	**MTH 4E11**	**Elective**	**Graph Theory**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand graph, vertex, path and cycles					U	(C,P)	15	2	4
CO 2	Explain connectivity in communication networks					U	(C,P)	10	2	
CO 3	Develop matchings and coverings in bipartite graphs					Ap	(C,P)	25	2	
CO 4	Explain chromatic number and related topics					U	(C,P)	15	3	
CO 5	Illustrate coloring problem and study some special graphs					U	(C,P)	15	3	

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

Module 1

Basic concepts of Graph.Trees, Cut edges and Bonds, Cut vertices, CayleysFormula, The Connector Problem, Connectivity, Blocks, Construction of Reliable Communication Networks,EulerTours,HamiltonCycles,TheChineesePostmanProblem,TheTravelling SalesmanProblem.

Module 2

Matchings,MatchingsandCoveringsinBipartiteGraphs,PerfectMatchings, ThePer-sonnelAssignmentProblem,EdgeChromaticNumber,VizingsTheorem,TheTimetabling Problem, Independent Sets, RamseysTheorem

Module 3

VertexColouring-ChromaticNumber,BrooksTheorem,ChromaticPolynomial,Girth andChromaticNumber,AStorageProblem,PlaneandPlanarGraphs,DualGraphs,Eu- lersFormula,Bridges,KuratowskisTheorem,TheFive-ColourTheorem,DirectedGraphs, Directed Paths, DirectedCycles.

[Chapter 2 Sections 2.1(Definitions & Statements only), 2.2, 2.3, 2.4, 2.5; Chapter3Sections3.1,3.2,3.3;Chapter4Sections4.1(Definitions&Statementsonly),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 Sections7.1,7.2;Chapter8Sections8.1,8.2,8.4,8.5,8.6;Chapter9Sections(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, Reprint2013.

[2] **GeirAgnarsson, 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)in1991andAlliedPublishers(India)in1995

[4] **R. Balakrishnan& K. Ranganathan :** A Text Book of Graph Theory, Springer Verlag, 2nd edition2012

ELECTIVE 8 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures /week	CL	KC	Hrs	PO	PSO
E08	**MTH 4E12**	**Elective**	**Representation Theory**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand G-modules					U	(C,P)	15	2	4
CO 2	Develop idea of reducibility					Ap	(C,P)	10	2	
CO 3	Analyze orthogonality relations					An	(C,P)	25	2	
CO 4	Develop induced representations					Ap	(C,P)	15	3	
CO 5	Explain reciprocity law					U	(C,P)	15	3	

TEXT: Walter Ledermann, Introduction to Group Characters(Second Edition).

Module 1

Introduction,G-modules,Characters,Reducibility,PermutationRepresentations,Com-pletereducibility,Schurslemma,Thecommutant(endomorphism)algebra.(Sections:1.1 to1.8)

Module 2

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

Module 3

Induced representations, reciprocity law, the alternating group A5, Normal sub-groups, Transitive groups, the symmetric group, induced characters of S_n. (Sections: 3.1 to 3.4 & 4.1 to4.3)

References

[1] **C. W. Kurtis and I. Reiner:** Representation Theory of Finite Groups and Asso- ciativeAlgebras,JohnWiley&Sons,NewYork(1962)

[2] **Faulton:**TheReprsentationTheoryofFiniteGroups,LectureNotesinMathematics, No. 682, Springer1978.

[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 Representation of Finite Groups, Graduate Text in Mathematics, Vol42, Springer(1977).

ELECTIVE 9 IN SEMESTER IV

Course No	Code	Course Category	Name of the course	No. of Credits	No. Of hours of Lectures/ week	CL	KC	Hrs	PO	PSO
E09	**MTH 4E13**	**Elective**	**Wavelet Theory**	**3**	**5**					
CO	**CO Statement**									
CO 1	Understand basic properties of discrete fourier transforms					U	(C,P)	15	1	4
CO 2	Develop wavelets on ZN					Ap	(C,P)	10	2	
CO 3	Interpret complete orthonormal sets in Hilbert space					U	(C,P)	15	3	
CO 4	Explain Fourier transform and convolutions					U	(C,P)	15	2	
CO 5	Explain wavelets and Fourier transform on ℝ					U	(C,P)	25	3	

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

Module 1

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

Construction of wavelets on Z_N- The First Stage , Construction of Wavelets on Z_N: The Iteration Step.[Chapter 2: sections 2.1 to 2.3; Chapter 3: sections 3.1 and 3.2]

Module 2

Wavelets on Z : A^2(Z), Complete orthonormal sets in Hilbert spaces ,L^2([π, π)) and Fourier series ,The Fourier Transform and convolution on $A^2(Z)$, First stage Waveletson Z , Implementation and Examples.[Chapter 4: sections 4.1 to 4.6 and4.7]

Module 3

Wavelets on R :$L^2(R)$ and approximate identities , The Fourier transform on R , Mul- tiresolution analysis and wavelets, Construction of MRA . [Chapter 5: sections 5.1 to 5.4]

References:

[1] **C.K. Chui :** An introduction to wavelets, AcademicPress,1992

[2] **Jaideva. C. Goswami, Andrew K Chan:** Fundamentals of Wavelets Theory Al- gorithmsandApplications,JohnWileyandSons,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.

MODEL QUESTION PAPER

I/II/III/IV SEMESTER M.Sc. DEGREE EXAMINATION (CBCSS), Month & Year

Mathematics
Course Code: Course Name

Time : 3hrs MaximumWeightage: 30

Part A (Answer all the questions. Weightage 1 for each question)

1. from Module 1
2. from Module 1
3. from Module 2
4. from Module 2
5. from Module 3
6. from Module 3
7. from Module 1/2/3
8. from Module 1/2/3

Part B (Answer any six questions. Weightage 2 for each question)

9. from Module 1
10. from Module 1
11. from Module 1
12. from Module 2
13. from Module 2
14. from Module 2
15. from Module 3
16. from Module 3
17. from Module 3

Part C (Answer any two questions. Weightage 5 for each question)

18. from Module 1
19. from Module 2
20. from Module 3
21. from Module 1/2/3

MODEL QUESTION PAPER

FIRST SEMESTER M.Sc. DEGREE EXAMINATION (CBCSS)

Mathematics

MTH1C05: NUMBER THEORY

Time: 3hrs Maximum Weightage: 30

Part A (Answer all the questions. Weightage 1 for each question)

1. Prove that if f is multiplicative then $f(1) = 1$
2. With usual notations, prove that $\Lambda * u = u'$
3. Prove that for every $n > 1$, there exist n consecutive composite numbers.
4. State Abel's identity.
5. Let p be an odd prime $\equiv 1 (mod\ 4)$, prove that $\sum_{r=1}^{p-1} r(r|p) = 0$.
6. Determine whether -104 is a quadratic or non residue mod 997.
7. Define the Affine Cryptosystem,
8. Find the inverse of the matrix $\begin{pmatrix} 1 & 3 \\ 4 & 3 \end{pmatrix}$ mod 5.

Part B (Answer any six questions. Weightage 2 for each question)

9. If $n \geq 1$, prove that $\varphi(n) = n \prod_{p|n} \left(1 - \frac{1}{p}\right)$.
10. Prove that $\prod_{t|n} t = n^{d(n)/2}$, where $d(n)$ denotes the number of positive divisors of n.
11. State and prove Legendre's identity.
12. Determine those odd primes for which 3 is a quadratic residue.
13. Show that for all $x \geq 1$; $\left|\sum_{n \leq x} \frac{\mu(n)}{n}\right| \leq 1$, with equality holding only if $x < 2$.
14. With usual notations, prove that, for $x \geq 0$, $\frac{(\log x)^2}{2\sqrt{x}\, log 2} \geq \frac{\psi(x)}{x} - \frac{\vartheta(x)}{x} \geq 0$.
15. Using the Prime Number Theorem, show that $\lim_{x \to \infty} \frac{H(x)}{x \log x} = 0$, where

    $H(x) = \sum_{n \leq x} \mu(n) \log n$ for $x \geq 1$.

16. Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \in M_2(\frac{\mathbb{Z}}{\mathbb{N}\mathbb{Z}})$ with $D = ad - bc$. Show that the statements below are equivalent:

(i) $\gcd(D, N) = 1$

(ii) A has an inverse

(iii) $A$is a bijection of $(\frac{\mathbb{Z}}{\mathbb{N}\mathbb{Z}})^2$ with itself.

17. Prove that the product of two affine enciphering transformations is also an enciphering transformation.

Part C (Answer any two questions. Weightage 5 for each question)

18. With usual notations, prove that there is a constant A such that

$\sum_{p\leq x}\left(\frac{1}{p}\right) = \log(\log x) + A + O\left(\frac{1}{\log x}\right)$for all $x \geq 2$.

19. Prove that the arithmetical function f with $f(1) \neq 0$ form an abelian group under the operation of Dirichlet Multiplication.

20. (a) State Gauss Lemma and prove the quadratic reciprocity law.

(b) Find the quadratic residues and non-residues modulo 13.

21. Describe RSA with an example.

MODEL QUESTION PAPER

SECOND SEMESTER M.Sc. DEGREE EXAMINATION (CBCSS)

Mathematics

MTH2C06: ALGEBRA II

Time: 3hrs — Maximum Weightage: 30

Part A (Answer all the questions. Weightage 1 for each question)

1. Show that $Q[x]/\langle x^2 - 2 \rangle$ is a field
2. Let E be an extension field of a field F. Let $\alpha \in E$ be algebraic over F. Define irreducible polynomial for α over F.
3. Find the primitive 5 th root of unity in Z_{11}.
4. Describe the group $G(\mathbf{Q}(\sqrt{2}, \sqrt{3})/\mathbf{Q})$
5. Let K be a finite normal extension of F and let E be an extension of F, where $F \leq E \leq K \leq \bar{F}$. Prove that K is a finite normal extension of E
6. Find $\emptyset_8(x)$ over Q.
7. Prove that R(i) = C.
8. Check whether $\alpha = \sqrt{\pi} \in C$ is algebraic over Q.

Part B (Answer any six questions. Weightage 2 for each question)

9. Construct a field of order 9.
10. Let E be an extension field of F. Let $\alpha \in E$ be algebraic of odd degree over F. Show that α^2 is algebraic of odd degree over F and $F(\alpha) = F(\alpha^2)$.
11. Show that regular 9 – gon is not constructable.
12. Let $\{\sigma_i | i \in I\}$ be a collection of automorphisms of a field E. Then prove that the set $E_{\{\sigma_i\}}$ of all a$\in$ E forms a subfield of E.
13. If $E \leq \bar{F}$ is a splitting field over F, Prove that every irreducible polynomial in F[x] having a zero in E splits in E.
14. Prove that every field of characteristic zero is perfect.
15. Let F be a field of characteristic zero, and let $F \leq E \leq K \leq \bar{F}$, where E is a normal extension of F and K is an extension of F by radicals. Prove that G (E /F) is a solvable group.
16. Let f(x) be a polynomial in F[x] of degree n. Let $E \leq \bar{F}$ be the splitting field of f(x) over F in $\bar{F}$. What bounds can be put on [E:F] ?
17. Prove that the Galois group of pthcyclotomic extension of Q for a prime p is cyclic of order p-1.

Part C (Answer any two questions. Weightage 5 for each question)

18. a) Construct a basis of Q($2^{1/2}, 2^{1/3}$) over Q.
    (b) Show that Q ($2^{1/2}, 2^{1/3}$) = Q($2^{1/6}$).
19. State and prove isomorphism extension theorem.
20. State and prove a necessary condition for a regular n – gon is constructable with a compass and a straightedge
21. State and prove kronecker's theorem

Model question paper
THIRD SEMESTER M.Sc. DEGREE EXAMINATIONS,
MTH3C11:Multivariable Calculus and Geometry

Time: 3 hrs Max.Weight: 30

Part A

*Answer **all** questions. Each question carries 1 weightage*($8 \times 1 = 8$ Weightage)

1. Prove that a linear operator A on a finite dimensional vector space X is one-to- one if and only if the range of A is all of X
2. Prove that to every $A \in L(\mathbb{R}^n, \mathbb{R}^1)$, corresponds a unique $y \in, \mathbb{R}^n$ such that $Ax = x.y$
3. Show that if $A \in L(\mathbb{R}^n, \mathbb{R}^m)$ and if $x \in \mathbb{R}^n$,then $A'(x) = A$
4. Show that a linear operator A on $\mathbb{R}^n$ is invertible if and only if $\det[A] \neq 0$
5. If $f(0,0) = 0$ and $f(x,y) = \frac{xy}{x^2+y^2}$ if $(x,y) \neq (0,0)$.Prove that $(D_1 f)(x,y)$ and $(D_2 f)(x,y)$ exist at every point of $\mathbb{R}^2$, although f is not continuous at $(0,0)$
6. State and prove contraction principle.
7. Prove that if the tangent vector of a parametrized curve is constant , the image of the curve is a straight line.
8. If $\gamma(t)$ is a regular curve prove that its arc length s starting at any point of γ is a smooth function of t

Part B

*Answer any **six**questions. Each question carries 2 weightage.*($6 \times 2 = 12$ Weightage)

9. Prove that $L(\mathbb{R}^n, \mathbb{R}^m)$ is a metric space with the metric $d(A,B) = \|A - B\|$; $A, B \in L(\mathbb{R}^n, \mathbb{R}^m)$
10. Prove that Ω,the set of all invertible linear operator on $\mathbb{R}^n$ is an open set in $(\mathbb{R}^n)$. Also prove that the mapping $A \to A^{-1}$ is continuous on Ω.
11. Suppose f maps an open set $E \subset \mathbb{R}^n$ into $\mathbb{R}^m$. Then prove that $f \in C'(E)$ if and only if the partial derivatives $D_j f_i$ exist and continuous on E for $1 \leq i \leq m, 1 \leq j \leq n$.
12. Prove that the sphere of radius 1 with center at the origin is a surface.
13. Let $\gamma: (\alpha, \beta) \to \mathbb{R}^2$ be a unit speed curve, let $s_0 \in (\alpha, \beta)$ and φ_0 be such that $\dot{\gamma}(s_0) = (\cos\varphi_0, \sin\varphi_0)$.Then prove that there exist a unique smooth function $\varphi: (\alpha, \beta) \to \mathbb{R}$ such that $\varphi(s_0) = \varphi_0$ and that $\dot{\gamma}(s) = (\cos \varphi(s), \sin \varphi(s))$ for every $s \in (\alpha, \beta)$
14. Compute κ, τ, t, n and b for the the curve $\gamma(t) = \left(\frac{4}{5}\cos t, 1 - \sin t, -\frac{3}{5}\cos t\right)$ and verify that the Frenet-Serret equations are satisfied.
15. Let $f: S_1 \to S_2$ be a diffeomorphism .If σ_1 is an allowable surface patch on S_1 , then prove that $f \circ \sigma_1$ is an allowable surface patch on S_2
16. State and prove Euler's theorem for oriented surface.
17. Show that the normal curvature of any curve on a sphere of radius r is $\pm\frac{1}{r}$

Part C

*Answer any **two** questions. Each question carries 5 weightage.*(2 × 5 = 10 Weightage)

18. State and prove inverse function theorem
19. State and prove implicit function theorem
20. Define signed curvature of a curve in $\mathbb{R}^2$. Let $k: (\alpha, \beta) \to \mathbb{R}$ be any smooth function , prove that there is a unit speed curve $\gamma: (\alpha, \beta) \to \mathbb{R}^2$ whose signed curvature is k.If $\bar{\gamma}: (\alpha, \beta) \to \mathbb{R}^2$is any unit speed curve whose signed curvature is k , how does γ and $\bar{\gamma}$ are related? Also prove that any regular curve whose curvature is a positive constant is part of a circle.
21. Let $\sigma: U \to \mathbb{R}^3$ be a surface patch. Let $(u_0, v_0) \in U$ and $\delta > 0$ be such that the closed disc $R_\delta = \{(u, v) \in \mathbb{R}^2: (u - u_0)^2 + (v - v_0)^2 \leq \delta^2\}$ with centre (u_0, v_0) and radius δ is contained in U.Then prove that's $\lim_{\delta \to 0} \left(\frac{\mathcal{A}_N(R_\delta)}{\mathcal{A}_\sigma(R_\delta)}\right) = |K|$ where K is the Gaussian curvature of σ at $\sigma(u_0, v_{0)}$.