PANJAB UNIVERSITY CHANDIGARH- 160 014 (INDIA)

(Estted. under the Pnjab Univerasity Act VII of 1947-enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABI

FOR

B.Sc. (HONOUR SCHOOL) MATHEMATICS
1ST TO 6TH SEMESTER

&

M.Sc. (HONOUR SCHOOL) MATHEMATICS
1ST TO 4TH SEMESTER

EXAMINATIONS 2012- 2013

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OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR B.Sc.(HONS.SCHOOL) IN MATHEMATICS SEMESTERS I, II, III, IV, V & VI FOR THE ACADEMIC SESSION 2012-2013

Outlines of Tests

Semester I

(I) Preliminary English (common to all Hons. School)

(II) Environment & Road Safety Education -do-

(III) Major Papers-2

Paper I : Math 301S : Calculus-I
Paper II : Math 302S : Coordinate Geometry

(IV) Subsidiary Courses-2

(1) Statistics

Paper I : SC 101S : Probability & Statistical Methods-I
Paper II : SCP 102S : Practicals of Statistical Methods-II

Syllabus of these two subsidiary papers will be provided by the Statistics Department, Panjab University, Chandigarh.

(2) Anyone of the following subjects:

Chemistry, Economics, Geography, Geology,
Life Sciences, Physics, Philosophy

Semester II

(I) Preliminary English (common to all Hons. School)

(II) Environmental Education -do-

(III) Major Papers-2

Paper I : Math 321S : Calculus-II
Paper II : Math 322S : Linear Algebra

(IV) Subsidiary Courses-2

(1) Statistics

Paper I : SC 121S : Probability & Statistical Methods-II
Paper II : SCP 122S : Practicals of Statistical Methods-II

Syllabus of these two subsidiary papers will be provided by the Statistics Department, Panjab University, Chandigarh.
(2) Same Subsidiary as opted in Semester I

Semester III

Major Papers-3

Paper-I: Math 401S : Number Theory
Paper-II: Math 402S : Analysis-I
Paper III: Math 403S : Ordinary Differential Equations

Subsidiary Courses-2

(1) Statistics and Computational Methods


Syllabus of these two subsidiary papers will be provided by the Statistics Department, Panjab University, Chandigarh.

(2) Same Subsidiary as opted in Semester III

The syllabus for subsidiary subjects will be available with the concerned departments.

Semester-IV

Major Papers-3

Paper I : Math 421S : Algebra
Paper II : Math 422S : Analysis-II
Paper III: Math 423S : Mechanics

Subsidiary Courses-2

(1) Statistics and Computational Methods

Paper I : SC 221S : Applied Statistics-II
Paper II : SCP 222S : Practicals of Applied Statistics-II

Syllabus of these two subsidiary papers will be provided by the Statistics Department, Panjab University, Chandigarh.

(2) Same Subsidiary as opted in Semester III

The syllabus for subsidiary subjects will be available with the concerned departments.
Semester V

Paper-I : Math 501S : Algebra
Paper-II : Math 502S : Calculus of Several Variables and Improper Integrals
Paper-III : Math 503S : Some Special Functions and Integral Transforms
Paper-IV : Math 504S : Number Theory I
Paper-V : Math 505S : Discrete Mathematics and Graph Theory

Semester VI

Paper-I : Math 521S : Linear Algebra
Paper-II : Math 522S : Lebesgue Integration and Fourier Series
Paper-IV : Math 524S : Number Theory II
Paper-V : Math 525S : Numerical Analysis
Subsidiary courses being taught to the students of other Science Departments

B.Sc. (Hons.School) First Year

**Semester I**

(for students without background in Mathematics)
Math 105S : Algebra and Geometry

(for students with background in Mathematics)
Math 115S: Advanced Calculus & Geometry

**Semester II**

(for students without background in Mathematics)
Math 125S: Calculus

(for students with background in Mathematics)
Math 135S: Linear Algebra

B.Sc. (Hons.School) Second Year

**Semester III**

(For Students without background in Math.)
Math 205S : Matrices

(For Students with background in Math.)
Math 215S : Differential Equations, Fourier Series, Integral Transforms and Complex Analysis

**Semester IV**

(For Students without background in Math.)
Math 225S : Vector Analysis, Differential Equations and Transforms

(For Students with background in Math.)
Math 235S : Integral Transforms and Complex Analysis
Outlines of tests syllabi and courses of reading for B.Sc. (Honours School) First Year English Subsidiary (Semester System)

FIRST SEMESTER

Objectives:

The objective of teaching English to the science students is to create general awareness among them about literature and its impact on their lives. At the same time, it is expected that the students, on reading this course, shall develop proficiency in reading and writing skills, while acquiring a sensitive and analytical attitude towards literature in particular, and life in general. It is with this aim in mind that the new text has been selected and it is hoped that the objectives of the course will not only be reflected but also realized through necessary shift in the teaching practices, design of the question paper and mode of evaluation.

Note:

(i) There will be one paper of 80 marks, 10 marks are reserved for the Internal Assessment and 10 for the Practical Work. Total is 100.

(ii) The paper shall consist of Two Units. Unit I will be text specific and Unit II shall deal with different aspects of communications and language learning skills.

(iii) For Unit I, the prescribed text is Varieties of Expression, Ed. A. H. Tak, Foundation Books, which shall replace the existing text Patterns in Prose by Jagdish Chander, P.U., Chandigarh. It may be pointed out here that only certain sections of this text i.e prose and drama are prescribed. Poetry has been deleted completely. Only five prose and five plays have been recommended for the study. The relevant sections, however, are as follows:

Prose:

I. The Judgement Seat of Vikramaditya, Sister Nivedita
II Engine Trouble,  R. K. Narayan
III The Conjurer’s Revenge, Stephen Leacock

Drama:

I The Rising of the Moon, Lady Gregory
II Waterloo, Arthur Conan Doyle

(iv) No text book is recommended for Unit II, but a few books that may be used for this Unit are listed towards the end Unit II shall consist of the following:

Communication: It shall focus on different aspects of communication, types of communication, and significance of positive attitude in improving communication.
Writing Skills: This section shall focus on précis-writing, letters of all kinds; curriculum vitae, short, formal reports (no exceeding 200 words); public notices and advertisements relating to product promotion etc.,

Modern Forms of Communication: Here special emphasis shall be given to teaching the format of e-mails, fax messages, telegrams, audio-visual aids and power-point presentations. Apart from this, the students shall also be given basic lessons in effective listening, non-verbal communication, how to prepare for an interview and group discussion etc.,

Practical work:-

Teacher should assign some project or practical work to the students. This should be in the nature of guided activity, which the students shall have to complete under the direct supervision of the teacher. The students may be given projects on a variety of subjects relating to their discipline i.e. science in general or a specific area of science they are specializing in. Preferably, they should be given minor projects (to be completed within less than two weeks, and length not exceeding 20 pages) in consultation with teachers of science. However, the evaluation of the projects should be done only by the Language Teachers, who must keep all the basic criteria of good writing in mind while doing so.

Note: In case of private candidates and students of School of Open Learning, the marks obtained by them out of 80 will be proportionately increased out of 100.

Testing Scheme:

The examination paper shall be divided into two sections, corresponding to two units already proposed in the syllabus. The distribution of questions and marks in Section I shall be as follows:

Section I (It is text-based and corresponds to unit I in the syllabus)

Q1. It shall consist of five short questions (not exceeding 100-120 words) out of which a student will be expected to attempt any three. This question shall be based upon the prescribed text Varieties of Expression and cover a wide range of issues, topics and problems. It shall consist of 12 marks.

Q2. It shall consist of two long questions (not exceeding 300-350 words) out of which a student will be expected to attempt only one. This question shall have internal choice, be based upon the prescribed text Varieties of Expression. This shall carry 10 marks.

Note: The question 1 & 2 should be so designed as to cover all the chapters prescribed, as well as the major issues and problems listed therein.

Q3. It shall consist of an Unseen Passage for Comprehension (not more than 800 words), with minimum six questions at the end. These questions should be designed in such a way that we are able to test a student’s comprehension ability, language/presentation skills and vocabulary etc. This question shall be of 12 marks.
Q.4. It shall exclusively be a test of vocabulary, but designed strictly on the lines of various exercises given at the end of each chapter in the prescribed text. The candidate shall be given six words in one column and asked to match them with words/meanings in the next column. This shall carry **6 marks**.

**Section II (Based upon Unit II)**

Q.5 (a) The students shall be asked to write a short survey report on a situation, incident, problem of science or the possibility of starting a new scientific venture (in about 150-200 words). The students shall be given an internal choice in this question. This question shall carry 8 marks.

   (b) This question shall be on notices/advertisements of various types (as mentioned in the syllabus). It’ll carry **4 marks**.

Q.6. This question shall test a student’s ability to write letters of various kinds (in not more than 250 words). Again, there will be internal choice here and the question will be of **8 marks**

Q.7 There will test a student’s ability to write a Précis, A passage of about 200 words shall be given and the students shall have to write a précis of about 70 words (including the title). This question shall carry **10 marks**.

Q.8 This question shall test a student’s understanding of various aspects of communication and modern forms of communication. It shall be divided into two parts:

   (a) Two short questions to be attempted (in not more than 100-120 words each) on different aspects of communication. It’ll carry **6 marks**.

   (b) Definitions/format of modern forms of communication to be tested. This shall again carry **4 marks**.

**Suggested Reading:**


SECOND SEMESTER

Objectives:

The objective of teaching English to the science students is to create general awareness among them about literature and its impact on their lives. At the same time, it is expected that the students, on reading this course, shall develop proficiency in reading and writing skills, while acquiring a sensitive and analytical attitude towards literature in particular, and life in general. It is with this aim in mind that the new text has been selected and it is hoped that the objectives of the course will not only be reflected but also realized through necessary shift in the teaching practices, design of the question paper and mode of evaluation.

Note:

(i) There will be one paper of 80 marks, 10 marks are reserved for the Internal Assessment and 10 for the Practical Work. Total is 100.

(ii) The paper shall consist of Two Units. Unit I will be text specific and Unit II shall deal with different aspects of communication and language learning skills.

(iii) For Unit I, the prescribed text is Varieties of Expression, Ed. A. H. Tak, Foundation Books, which shall replace the existing text Patterns in Prose by Jagdish Chander, P.U., Chandigarh. It may be pointed out here that only certain sections of this text i.e prose and drama are prescribed. Poetry has been deleted completely. Only five prose and five plays have been recommended for the study. The relevant sections, however, are as follows:

Prose:

I J. C. Bose, Aldous Huxley
II The Position of Women in Ancient India, Padmini Sen Gupta

Drama:

I The Proposal, Anton Chekhov
II Riders to the Sea, J. M. Synge
III Lithuania, Rupert Brooke

(iv) No text book is recommended for Unit II, but a few books that may be used for this Unit are listed towards the end Unit II shall consist of the following:

Communication: It shall focus on different aspects of communication, types of communication, and significance of positive attitude in improving communication.
Writing Skills: This section shall focus on précis-writing, letters of all kinds; curriculum vitae, short, formal reports (no exceeding 200 words); public notices and advertisements relating to product promotion etc.,

Modern Forms of Communication: Here special emphasis shall be given to teaching the format of e-mails, fax messages, telegrams, audio-visual aids and power-point presentations. Apart from this, the students shall also be given basic lessons in effective listening, non-verbal communication, how to prepare for an interview and group discussion etc.,

Practical work:-

Teacher should assign some project or practical work to the students. This should be in the nature of guided activity, which the students shall have to complete under the direct supervision of the teacher. The students may be given projects on a variety of subjects relating to their discipline i.e. science in general or a specific area of science they are specializing in. Preferably, they should be given minor projects (to be completed within less than two weeks, and length not exceeding 20 pages) in consultation with teachers of science. However, the evaluation of the projects should be done only by the Language Teachers, who must keep all the basic criteria of good writing in mind while doing so.

Note: In case of private candidates and students of School of Open Learning, the marks obtained by them out of 80 will be proportionately increased out of 100.

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(b) This question shall be on notices/advertisements of various types (as mentioned in the syllabus). It’ll carry 4 marks.

Q.6. This question shall test a student’s ability to write letters of various kinds (in not more than 250 words). Again, there will be internal choice here and the question will be of 8 marks.

Q.7 There will test a student’s ability to write a Précis, A passage of about 200 words shall be given and the students shall have to write a précis of about 70 words (including the title). This question shall carry 10 marks.

Q.8 This question shall test a student’s understanding of various aspects of communication and modern forms of communication. It shall be divided into two parts:

(a) Two short questions to be attempted (in not more than 100-120 words each) on different aspects of communication. It’ll carry 6 marks.

(b) Definitions/format of modern forms of communication to be tested. This shall again carry 4 marks.

Suggested Reading:


UNIT I (ENVIRONMENT)

1. **Environment Concept** :
   Introduction, concept of biosphere—lithosphere, hydrosphere, atmosphere; Natural resources—their need and types; principles and scope of Ecology; concepts of ecosystem, population, community, biotic interactions, biomes, ecological succession.

2. **Atmosphere** :
   Parts of atmosphere, components of air; pollution, pollutants, their sources, permissible limits, risks and possible control measures.

3. **Hydrosphere** :
   Types of aquatic systems. Major sources (including ground water) and uses of water, problems of the hydrosphere, fresh water shortage; pollution and pollutants of water, permissible limits, risks and possible control measures.

4. **Lithosphere** :
   Earth crust, Soil—a life support system, its texture, types, components, pollution and pollutants, reasons of soil erosion and possible control measures.

5. **Forests** :
   Concept of forests and plantations, types of vegetation and forests, factors governing vegetation, role of trees and forests in environment, various forestry programmes of the Govt. of India, Urban forests, Chipko Andolan.

6. **Conservation of Environment** :
   The concepts of conservation and sustainable development, why to conserve, aims and objectives of conservation, policies of conservation; conservation of life support systems—soil, water, air, wildlife, forests.

7. **Management of Solid Waste** :
   Merits and demerits of different ways of solid waste management—open, dumping, landfill, incineration, resource reduction, recycling and reuse, vermicomposting and vermiculture, organic farming.

8. **Indoor Environment** :
   Pollutants and contaminants of the in-house environment; problems of the environment linked to urban and rural lifestyles; possible adulterants of the food; uses and harms of plastics and polythene; hazardous chemicals, solvents and cosmetics.
9. **Global Environmental Issues:**

Global concern, creation of UNEP; Conventions on climate change, Convention on biodiversity; Stratospheric ozone depletion, dangers associated and possible solutions.

10. **Indian Laws on Environment:**

Indian laws pertaining to Environmental protection: Environment (Protection) Act, 1986; General information about Laws relating to control of air, water and noise pollution. What to do to seek redressal.

11. **Biodiversity:**

What is biodiversity, levels and types of biodiversity, importance of biodiversity, causes of its loss, how to check its loss; Hotspot zones of the world and India, Biodiversity Act, 2002.

12. **Noise and Microbial Pollution:**

Pollution due to noise and microbes and their effects.

13. **Human Population and Environment:**


14. **Social Issues:**

Environmental Ethics: Issues and possible solutions, problems related to lifestyle, sustainable development; Consumerisms and waste generation.

15. **Local Environmental Issues:**

Environmental problems in rural and urban areas, Problem of Congress grass & other weeds, problems arising from the use of pesticides and weedicides, smoking etc.

**Practicals:**

Depending on the available facility in the college, a visit to Vermicomposting units or any other such non-polluting eco-friendly site or planting/caring of vegetation/trees could be taken.

*Note: Above 15 topics to be covered in 25 hour lectures in total, with 2 lectures in each topics from 2 to 11 and one each for the topics 1 and 12 to 15.*

**UNIT II (ROAD SAFETY)**

1. Concept and Significance of Road Safety.
2. Role of Traffic Police in Road Safety.
4. Traffic Signs.
5. How to obtain Driving License.
7. Common Driving mistakes.
8. Significance of First-aid in Road Safety.
9. Role of Civil Society in Road Safety.
Examination Pattern:

- Seventy multiple choice questions (with one correct and three incorrect alternatives and no deduction for wrong or un-attempted question).
- The paper shall have two units: **Unit I (Environment) and Unit II (Road Safety).**
  - Unit I shall comprise of 50 questions with minimum of 2 questions from each topics 1, and 12 to 15 and minimum of 4 questions from topics 2 to 11.
  - Unit II shall comprise of 20 questions with minimum of 1 question from each topics 1 to 10.
- The entire syllabus of Unit I is to be covered in 25 hours and that of Unit II is to be covered in 10 hours.
- All questions are to be attempted.
- Qualifying Marks 33 per cent i.e. 23 marks out of 70.
- Duration of examination : 90 minutes.
- The paper setters are requested to set the questions strictly according to the syllabus.

Suggested Readings

2. Road Safety Signage and Signs (2011), Ministry of Road Transport and Highways, Government of India.

Websites:

(a) [www.chandigarhpolice.nic.in](http://www.chandigarhpolice.nic.in)
(b) [www.punjabpolice.gov.in](http://www.punjabpolice.gov.in)
(c) [www.haryanapolice.gov.in](http://www.haryanapolice.gov.in)
(d) [www.hppolice.nic.in](http://www.hppolice.nic.in)
B.Sc.(Honours School) in Mathematics

Semester I

Major Papers-2

Paper I

MATH 301S: Calculus-I

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective

Calculus is one of the major branches of mathematics that finds application in almost all the fields of science. This course is an introduction to calculus. Students will be introduced to the concepts of limits, derivatives, integrals and infinite series.

Note : 1. The question paper will have eight questions. Candidates will attempt five questions.
   2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
   3. All questions carry equal marks.

PART –I

Differential Calculus

(Scope as in Chapters 1,2,3 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

Integral Calculus

Integration of functions. Reimann sum and definite integrals. Properties, Area and the Mean value theorem, The fundamental theorem.
(Scope as in Chapters 4 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

PART –II

Integral Calculus

(Scope as in Chapters 5 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

**Infinite Series**


(Scope as in Chapters 8 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

**Suggested Readings**

Math302S: Coordinate Geometry

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective
Geometry is derived from real world measurements of lines, planes and solids. A systematic logical approach is required to understand it. The objective is to provide basic understanding of the geometry of two and three dimensions.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART –I

Pair of Straight lines: Joint equation of pair of straight lines and angle between them, condition of parallelism and perpendicularity, joint equation of the angle bisectors, joint equation of lines joining origin to the intersection of a line and a curve.
Circle: General equation of circle, circle through intersection of two lines, Tangents and Normals, Chord of contact, pole and polar, pair of tangents from a point, equation of chord in terms of midpoint, angle of intersection and orthogonality, power of a point w.r.t circle, radical axis, coaxial family of circles, limiting points.
Conic: General equation of conic, Tangents, normals, chord of contact, pole and polar, of tangents from a point, equation of chord in terms of midpoint, diameter. Conjugate diameters of ellipse and hyperbola, special properties of parabola, ellipse and hyperbola, conjugate hyperbola, asymptotes of hyperbola, rectangular hyperbola.
Transformation of axes in two dimensions: shifting of origin, rotation of axes, the second degree equation \( S=ax^2+2hxy+by^2+2gx+2fy+c=0 \), its invariants \( t, \Delta \) and \( O \). Reduction of the second degree equation into standard form. Identification of curves represented by \( S=0 \) (including pair of lines).
Polar coordinates: Polar equations of straight lines, circles and conics. Polar equation of chords, tangents normals only.

PART –II

Review of lines and planes in 3-dimension, change of axes, shift of origin, rotation of axes, sphere, section of a sphere by a plane. Sphere through a given circle. Intersection of a line and sphere, tangent line, tangent plane, angle of intersection of two spheres and condition of orthogonality, power of a point w.r.t a sphere, Radical planes, radical axis, radical centre, coaxial family of spheres, limiting points. Cylinder, Cone with vertex at origin as the graph of homogeneous equation of second degree in \( x,y,z \), cone as a surface generated by a line passing through fixed curve and a fixed point outside the plane of the curve, reciprocal cones, right
circular and elliptic cones, right circular cone as a surface of revolution obtained by rotating the curve in a plane about an axis, enveloping cones, ellipsoid, equations of hyperboloids, paraboloids in the standard form, tangent planes and normals.

References

Semester II

Major Papers-2

Paper-I

MATH 321S: Calculus-II

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective
This course is in continuation of Calculus-I course. Here some advanced topics of calculus are included. This will help the students to understand the use of higher Calculus in various physical problems.

Note : 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Vector Analysis

(Scope as in chapters 10, 11 and 14 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

PART-II

Multivariable Functions:

(Scope as in Chapters 12 and 13 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition).

Suggested Readings
Objective
The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
   2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
   3. All questions carry equal marks.

PART–I

Systems of linear equations, matrices, rank, Gaussian elimination.

Determinants and their properties, Cramer's Rule.

Vector spaces, subspaces, bases and dimension, the null space and the column space of a matrix and their dimension.

Linear transformations, representation of linear transformations by matrices, change of basis, rank-nullity theorem, applications to difference equations and Markov chains.

PART–II

Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation, diagonalization.

Inner product, length, orthogonality, orthogonal projections, Gram-Schmidt orthonormalization process, least square problems, inner product spaces and their applications.

Diagonalization of symmetric matrices and quadratic forms.

Text Book

References
**B.Sc.(Hons. School) Second Year**

**Semester III**

**Major Papers-3**

**Paper I : Math 401S : Number Theory**

[7 hrs per week (including tutorials)]

Max.Marks : 100

[Final-80+Internal Assessment-20]

Time: 3hrs.

**Objective:**

The aim of this course is to teach the students the very basics of Elementary Number Theory starting with primes, congruences, quadratic residues, primitive roots, arithmetic functions. Apart from teaching the theory, stress will be on solving problems.

**Note:**

1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer two questions from each part.
3. All questions carry equal marks

**PART-I**

Divisibility, Greatest common divisor, fundamental theorem of arithmetic, congruences, residue classes and reduced residue classes, Euler-Fermat’s Theorem. Wilson’s Theorem, linear congruences, Chinese Remainder Theorem, polynomial congruences, Arithmetical functions, \( \phi(n) \), \( \tau(n) \), \( \mu(n) \), \( \sigma(n) \) etc. Mobius Inversion Formula.

**PART-II**

Primitive roots, indices, quadratic residues, Legendre’s symbol, Euler’s Criterion. Gauss’ Lemma, Quadratic reciprocity Law, Jacobi symbol. The Diophantine Equations \( x^2+y^2=z^2 \), \( x^4+y^4=z^4 \). (Scope as in Elementary Number Theory by D.M. Burton, Chapters 1-11). Farey Sequences (Scope as in Chapter 6 (Sections 6.1and 6.2) of Elementary Number Theory by Niven & Zuckerman)

**Suggested Readings**

Paper-II:Math 402S: Analysis -I

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
The aim of this course is to make the students learn about the metric spaces, series of real terms, relationship between continuous functions, compactness and connectedness of metric spaces.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

The real number system, least upper bound property, countable and uncountable sets, topology of real line and $\mathbb{R}^n$, metric spaces, compact sets, connected sets, arcwise connectedness, completion of a metric space, limit superior and limit inferior of a real sequence. Series, review of various tests of convergence, Abel’s test and Dirichlet’s test.

PART-II

Absolute convergence, alternating series. Addition and multiplication of series, rearrangements, limits of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuity, monotone functions, infinite limits and limits at infinity, the derivative of a real function, mean value theorems, L’Hospital’s rule, Taylor’s theorem.

[Scope as in the book ‘Principles of Mathematical Analysis’ by W.Rudin (3rd edition) Chapter I-V ]

Books recommended

Paper-III: Math 403S: Ordinary Differential Equations

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
To exhibit the techniques for obtaining solutions to ordinary differential equations and the basic ideas and theory behind those techniques.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

PART-I

Ordinary differential equations
Basic definitions: order and degree of differential equation, primitives, solutions of differential equations, Integral curves, isoclines.

First order differential equations: Linear, non-linear differential equations, Variables separable, homogeneous, non-homogeneous exact equations and integration factors, equations reducible to first order, Clairaut’s equation and Geometrical interpretation of first order differential equation, applications.

Successive approximations, Lipschitz condition, Statements of Existence and Uniqueness of solution of first order differential equations.

PART- II


Euler equation, regular singular points, ordinary points, series soultion. Method of Frobenius, Applications, Legendre’s, Hermite’s and Bessel’s equation.

Suggested Reading
Objective
This is a basic course in Group Theory, which is an integral part of Algebra. Group theory has applications in almost all major branches of science.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer two questions from each part.
3. All questions carry equal marks.

PART-I
Group Theory: Definitions, examples and simple properties of groups, order of an element, cyclic groups, connection with primitive roots, subgroups, cosets. Lagrange’s Theorem, subgroups of a cyclic group, subgroup generated by a subset, conjugacy, normal subgroups, quotient groups, homomorphisms, the isomorphism theorem.

PART II
Cayley’s Theorem, detailed study of $S_n$, simplicity of $A_n$, $n \neq 4$, Class Equations, Cauchy’s Theorem, Sylow’s Theorems, Direct Products. Elementary properties of finite p-groups, Fundamental Theorem of finite Abelian groups (scope as in Chapter 2 of I.N. Herstein - Topics in Algebra, Second Edition).

Suggested Readings
Paper-II: Math 422S: Analysis –II

[7 hrs per week (including tutorials)]  
Max.Marks :  100  
[Final-80+Internal Assessment-20]  
Time: 3hrs.

Objective

The objective of this course is to acquaint the students with the Riemann-Stieltjes integral as a generalisation of Riemann integral, Series of functions, interchange of limit and summations, differentiation and integration.

Note:  1. The question paper will have eight questions. Candidates will attempt five questions.  
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.  
3. All questions carry equal marks.

PART-I

Functions of bounded variation, Total variation, Additive property of total variation, functions of bounded variation expressed as the difference of increasing functions, rectifiable curves and arc length.

The Riemann-Stieltjes integrals with emphasis on Riemann Integral, step functions as integrators, additive and linearity properties of upper and lower integrals, Integrators of bounded variation, Mean value theorems for Riemann-Stieltjes integrals, Fundamental theorem of integral calculus, Mean value theorems for Riemann Integrals.

PART-II

Sequences and series of functions, uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, The Stone-Weierstrass Theorem power series, exponential and logarithmic functions, trigonometric functions.

[Scope as in the book Mathematical Analysis by T.M. Apostol , Chapter VI (upto 6.10), VII (upto 7.22), ‘Principles of Mathematical Analysis’ by W.Rudin (3rd edition) Chapter VII(Sections 7.1 to 7.18, 7.26). Chapter VIII upto Theorem 8.8]

Books recommended

Objective
The contents of this course is designed to make the students understand the Theoretical Principles of Mechanics and to clarify the physical foundations of dynamics and formulating suitable mathematical models for solutions.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Statics
Forces acting on a particle, parallel Forces, Couples, Moments and Coplanar forces acting on a rigid body and their resultant. Equilibrium of concurrent and Non-Concurrent coplanar forces, Friction, Virtual Work, Stable and unstable equilibrium and the Physical situations via problems.

PART-II

Dynamics
Motion in a straight line, Newton’s law of motion, Motion on an inclined plane. Motion under variable acceleration, Simple harmonic motion, Relative Motion, Projectiles, Work, Power, Energy.

Suggested Reading

2. A Text Book of Mechanics for TDC I, TDC II Publication Bureau, Panjab University, Chandigarh.
Objective
This course is a continuation of Math 421S which was an introduction to group theory. Besides covering some advanced topics of group theory, this course also covers the basics of Ring Theory and Module Theory.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

Groups and Rings

PART-I


PART-II

Polynomial rings, factorization in \( R[X] \) and in integral domains. Divisibility, Euclidean domains, unique factorization domains. Gauss’ lemma and Eisenstein’s criteria of irreducibility [Scope as in Chapters 7, 8, 9 and 10 of the book - Surjeet Singh and Quazi Zameeruddin: Modern Algebra, 7th edition].

Modules, definition and examples. Fundamental theorem of finitely generated modules over Euclidean domains [Scope as in Section 4.5 of the book – I.N. Herstein: Topics in Algebra].

Suggested Readings
Paper-II Math 502S: Calculus of Several Variables and Improper Integrals

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective
The objective of this course is to get the students acquainted with the functions of several variables taking values in several variables and improper integrals.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-1

Limit and continuity of functions between Euclidean spaces, Partial derivatives, directional derivatives and the Jacobian matrix, Derivatives and their elementary properties. Chain rule and its matrix form. Mean value theorem for differentiable functions, Sufficient condition for differentiability and sufficient condition for the equality of mixed partial derivatives, higher order derivatives, Taylor Theorem for function of n-variables.

[Scope as in the book ‘Mathematical Analysis’ by T. M. Apostol, Chapter 12(except 12.6) and Chapter 13]

PART-II

The measure of a bounded interval in $\mathbb{R}^n$, the Riemann integral of a bounded function defined on a compact interval in $\mathbb{R}^n$, Sets of measure zero and Lebesgue’s criterion for existence of a multiple Riemann Integral, Evaluation of a multiple integral by iterated integration.
[Scope as in the book ‘Mathematical Analysis’ by T. M. Apostol, Chapter 14 (up to 14.5)]

Improper integrals, Cauchy’s criterion, absolute convergence, tests for convergence and uniform convergence. Elementary notions of functions defined by integrals, continuity, differentiation under the integral sign. Beta and Gamma functions.

Suggested Reading
Paper III Math-503S: Some Special Functions and Integral Transforms

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time: 3hrs.

Objective
The objective of this course is to introduce the special functions as a solution of specific differential equations and acquaint the students with their properties. Integral Transforms and their inverse have been introduced which help in solving the various initial and boundary value problems.

Note
1. The question paper will have nine questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Legendre Polynomials – Orthogonal property of Legendre polynomials, Recurrence relations, Rodrigue’s formula, generating function, Orthogonal and Orthonormal functions, Fourier-Legendre series.

Chebyshev Differential Equation, Chebyshev polynomials of first and second kind and relation between them, Generating function, orthogonal property, Recurrence formulae, Fourier Chebyshev Series.

Bessel’s functions. Strum-Liouville Problem – Orthogonality of Bessel functions, Recurrence formulae, Generating function, Fourier-Bessel Series.

PART-II

Laplace Transforms, Inverse Laplace transform, Solution of initial value problems using Laplace transforms, Translation theorems, Laplace transform of Dirac-Delta function, Differentiation and Integration of Laplace transform, Convolution theorems, Laplace transform of periodic functions, Laplace transform method to solve some ordinary differential equations.


Books recommended
PAPER IV : MATH 504S : NUMBER THEORY-I

Objectives:
In continuation of first course Math 401-S, the remaining basics of Elementary Number Theory will be taught namely continued fractions, Pell’s equations, average order of arithmetic functions. Also the fundamentals of Geometry of Numbers and Partition Theory (two different branches of Number Theory) will be taught.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Continued fractions, periodic continued fractions, approximations of irrationals by rationals, Pell’s equation.

Partitions, Ferrers graphs, generating functions, Euler’s identity, Jacobi’s Triple Product formula, Representations of Numbers as sums of two and four squares.

PART--II

Binary quadratic forms, positive definite binary quadratic forms. Hermite’s estimate on the minima of positive definite quadratic forms and its application to representations of numbers as sums of three squares.

Minkowski’s Theorem in Geometry of Numbers and its applications to diophantine inequalities. Orders of magnitude and average orders of arithmetical functions.

Suggested Readings

Objective
The objective of this course is to acquaint the students with the basic concepts in Discrete Mathematics and Graph Theory.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Pigeonhole principle, Basic counting principles, permutations and combinations of sets and multisets, Binomial and multinomial theorems, Combinatorial identities, inclusion and exclusion principle, Recurrence relations, Generating functions solution of recurrence relations using difference equations and generating functions, Catalan numbers, Difference sequences and Sterling numbers. Partitions as associated to distribution identical objects in identical boxes.

PART-II
Elements of Graph Theory, Euclerian and Hamiltonian trails and cycles. Bipartite multigraphs, Trees, Spaning Trees, Algorithms for BFS and DFS trees weighted Graphs, Greedy algorithm and Prim’s Algorithm for generating minimum weight spanning graphs, Digraphs, Planer graphs, Euler formula and Chromatic numbers. (Scope as in Introductory Combinatorics, 5th Edition by Brualdi, Chapters 1-3,5-8,11 (except § 11.6), 12.1, 13.1,13.2)

Suggested Readings
Semester-VI

Paper I - Math 521S: Linear Algebra

Objective
The objectives of this subject is to develop a strong foundation in linear Algebra that provide a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc. Particular attention to canonical forms of linear maps, matrices, bilinear forms and quadratic forms is given.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I


Linear transformations, algebra of linear transformations. Dual spaces, matrices and linear transformations.

PART-II


References
Paper II Math-522S: Lebesgue Integration, Fourier Series and Calculus of Several Variables

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective
The objective of this Course is to get the students acquainted with Lebesgue Measure as generalizations of length, Lebesgue Integral and fundamental theorem of Calculus in Lebesgue Integral and Theory of Fourier Series.

Note
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Lebesgue outer measure, measurable sets and Lebesgue measure, Construction of a non-measurable set, measurable functions, Littlewood three principles.

Lebesgue integral of a bounded function over a set of finite measure, the integral of a non-negative function, the general Lebesgue Integral.
[Scope as in the relevant sections from Chapter 4 of the book ‘Real Analysis’, 3rd Edition, 2000 by H. L. Royden]

PART-II
Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity.
[Scope as in the relevant sections from Chapter 5 of the book ‘Real Analysis’, 3rd Edition, 2000 by H. L. Royden]

The set $L^2[a,b]$ of square integrable real valued functions on $[a,b]$. Orthogonal/orthonormal system of functions, the theorem of best approximation, the Fourier Series of a function relative to an orthonormal set, Bessel’s inequality, the Riemann-Lebesgue lemma, the Dirichlet integrals, Riemann’s Localization theorem, sufficient conditions for convergence of a Fourier Series at a particular point.

Suggested Reading:
Objective
The objective of the course is to enable the students to understand the basic concepts related to partial differential equations and acquaint with the methods of solutions of partial differential equations.

Note
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Ordinary differential equations in more than two variables: Simultaneous Differential equations of the first order and the first degree in three variables, Methods of their solution and applications, Pfaffian Differential forms and equations, solutions of Pfaffian Differential equations in three variables.


PART-II


[Scope as in the book ‘Differential Equations’ by I. N. Sneddon, Chapter 1, Chapter 2, Chapter 3(4, 5, 9)]

Books recommended
Paper IV: Math 524S : Number Theory- II

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective

The objectives of this course is to teach the fundamentals of different branches of Number Theory namely Geometry of Numbers, p-adic numbers, Partition Theory and Analytic Number Theory.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.

2. There will be four questions from each part and the students will be required to answer at least two questions from each part.

3. All questions carry equal marks.

Unit-I

Elementary results on the distribution of primes. Finite Abelian groups and their characters, Dirichlet’s Theorem on primes in Arithmetical progression. (Scope as in Chapters 4, 6, 7 of Analytic Number Theory by T.M.Apostol). Chevalley-Warning Theorem.

Unit-II

The congruence $a_1x_1^n + a_2x_2^r + ... + a_nx_n^e \equiv 0 \pmod{p}$, p-adic numbers, Ostrowksi’s Theorem; p-adic quadratic forms, Witt’s Lemma, Hasse - Minkowski’s theorem. (Scope as in Chapter 1 of Number theory by Borevich and Schafarevich).

Suggested Readings

Objective
The objective of the course is to expose the students with different aspects of basic numerical methods to solve polynomial equation, simultaneous equations, IVP, numerical differentiation and integration.

Note 1. The question paper will have eight questions. Candidates will attempt five questions.
    2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
    3. All questions carry equal marks.

PART-1

Error: Sources, Propogation and Analysis. [Ref.2 Chap 1]


Linear System of Equations:
Direct Methods: Gauss elimination method, Gauss-Jordan Elimination methods, Decomposition methods (Doolittle, Crout and Cholskey), Partition method and their error analysis.
Iterative Methods: Jacobi iterative method, Gauss-Seidel iterative method, Successive over relaxation iterative method, iterative method to determine A⁻¹, Convergence Analysis matrix.
Eigen Value Problems: Gerschgrun Theorem, Jacobi, Givens methods Householder’s method for Symmetric matrices, Ruthishauser, Power and Inverse Power method. [Ref.1, Chap 3]

PART-11

Interpolation and Approximation of Functions:

Quadrature, Gaussian Integration, Euler-Maclaurin Sum Formula, Numerical Integration of Singular and Fourier Integrals, Numerical Double Integration, [Ref. 3 Chap 5, Ref. 4 Chap 5.8].

**Numerical solutions to first order ordinary differential equations:** Taylor’s Series method, Picard’s Method, Euler’s and modified Euler’s methods, Runge Kutta methods [Ref. 3 Chap 7.1-7.5]

**Suggested Readings**


Mathematics Subsidiary Courses for students of other Science Departments [SESSION 2012-2013]

B.Sc.(Hons. School) 1st Year

Semester-I
(For students without background in Mathematics)

MATH 105S: Algebra and Geometry

[6hrs. Per Week]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective
The objective of this course is to study the basics of various topics of Mathematics which is a foundation for further learning in Mathematics, Physics, Statistics etc.

Note : 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

PART-I

Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations.
[Scope as in Chapters 3 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

Complex Numbers and Quadratic Equations Permutations and combinations Binomial Theorem sequences and series., Exponential and Logarithmic series. [Scope as in Chapters 5,7,8, 9, Appendix 1 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

PART-II

Matrices, Operations on Matrices, Determinants, singular and non-singular matrices, Adjoint and inverse of a matrix [Scope as in Chapters 3 , 4 of a Text book-‘Mathematics’ for Class XII, NCERT.Part I]

Co-ordinate Geometry: Rectangular Coordinate system. Straight lines. Circles and family of circles. Parabola, Ellipse and Hyperbola-their equations in standard form, .[Scope as in Chapters 10, 11 of a Textbook- ‘Mathematics’ for Class XI, NCERT.]

Three dimensional space, Coordinates of a point in three dimensional space.Distance between two points. Section Formula[Scope as in Chapter 12 of a Text book – ‘Mathematics’ for Class XI, NCERT.]

Suggested Readings

Scope as in the relevant chapters of the books:
Objective
The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

Note: The paper will consist of two parts. Each part will have five questions. The candidate will be required to attempt 6 questions selecting 3 questions from each part.

Advanced Calculus and Geometry


Multiple Integrals and Integral in vector fields: Double and triple integrals. Fubini’s Theorem without proof, Change of order of integration in double integrals, volume of a region in space, Triple integrals in spherical and cylindrical coordinates, substitution in multiple integrals.


Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke’s theorem (Applications only).


Plane Geometry: Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation $S=Ax^2+Bxy+Cy^2 +Dx+Ey+f=0$ into simpler forms by transformation of coordinate axes(without proof). Identification of curves represented by $S=0$. Invariance of discriminant $\Delta$ and trace $t$. Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

[Scope as in Chapters 1, 6(Sections 6.1-6.4), 7(Sections 7.1-7.8, 7.11-7.15) from Plane Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

Solid Geometry: Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

[Scope as in Chapters 1(Sections 1.1-1.6, 1.11-1.14), 2(Sections 2.1-2.5, 2.12, 2.13), 3(Sections 3.1-3.3), 4(Sections 4.6, 4.7, 4.10, 4.11) from Solid Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

Suggested Readings


Semester-II

(For students without background in Mathematics)

MATH 125S: Calculus

[6hrs. Per Week]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs.

Objective

This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

Part-I


Application of derivative : increasing and decreasing functions. Maxima and Minima. Rolle’s Theorem (without proof). Mean Value Theorem. Tangents and Normals. [Scope as in Chapters 6 of a Text book – ‘Mathematics’ for Class XII, NCERT.]


Part-II

Integral Calculus: Integral as antiderivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions. The definition of integral
of a real valued function of real variable as limit of sum motivated by the determination of area. Fundamental theorem of integral calculus. [Scope as in Chapters 7 & 8 of a Text book-‘Mathematics’ for Class XII, NCERT Part II]


**Suggested Readings**
Scope as in the relevant chapters of the books:

*(For Students with background in Mathematics)*

**MATH 135S: Linear Algebra**

(6 hrs/week)
(Marks: 100)
(Final-80+Internal Assessment-20)

Time: 3hrs

**Objective**
This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

**Note**: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer two questions from each part.
3. All questions carry equal marks.

**SEMESTER II: LINEAR ALGEBRA**

**PART I**


[Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7-5.9) of the book ‘Introduction to Linear Algebra’ by V. Krishnamurthy, V.P.Mainra and J. L. Arora, East-West Press Pvt. Ltd.]
PART II


Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

[Scope as in Chapters 2(Sections 2.16-2.19), 11(Sections 11.1-11.4, 11.7, 11.8), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of the book ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, 10th edition, S. Chand & Co.]

References


B.Sc. (Hons. School) Second Year

Semester-III
(For students without background in Mathematics)

MATH 205S: Matrices

[6 hrs per week]
Max. Marks: 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course familiarizes the students with the theory of matrices which are used in solving equations in mechanics and other streams used in Mathematics, Physics etc.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART – I

Symmetric and Skew symmetric, Hermitian and Skew Hermitian, Orthogonal and unitary matrices (Definitions and examples only).

Rank of a matrix, elementary transformations, reduction to normal form (methods only), elementary matrices, equivalence of matrices.
[Scope as in Chapter 4 of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002].

Vector as n-tuples. Linear dependence and independence of vectors. Rank of a matrix. Row rank, Column Rank and Determinantal Rank of a matrix.
[Scope as in Chapter 5(Sections 5.1-5.8) of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002].

[Scope as in Chapter 6(Sections 6.1-6.7) of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002].

PART-II

[Scope as in Chapters 11(Sections 11.1-11.4) of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002].

Orthogonal reduction of real symmetric matrices. Unitary reduction of Hermitian matrices (methods only).
[Scope as in Chapter 12(Sections 12.1-12.3, 12.6) of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

Similarity of matrices. Reduction to Diagonal form, diagonalizable matrices.

[Scope as in Chapters 13(Sections 13.1-13.4) of ‘A Text Book of Matrices’ by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

**Suggested Readings**


*(For students with background in Mathematics)*

**MATH 215S : Differential Equations and Fourier Series**

[6 hrs per week]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

**Objective**

The objective of the course is to enable the students to understand the basic concepts related to ordinary differential, partial differential equations and Fourier Series and their applications.

**Note :**

1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

**PART I: Ordinary Differential Equations**


Solution in series of second order linear differential equations with variable coefficients (in particular, solutions of Legendre’s and Bessel’s equations.)

Bessel functions, Legendre functions, their recurrence and orthogonal relations, Gamma and Beta functions.

**PART II: Fourier Series and Partial Differential Equations**


[Scope as in Sections 1.5.4, 4.6, 5.3.1, 5.3.2, 5.3.4, 5.4.1, 5.5, 6.1-6.4, 7.2, 7.4, 7.4.1, 7.5.1, 8.1, 8.2, 8.3, 8.5.4, 8.6 of Ref.1.]

**Suggested Readings**

Semester-IV
(For students without background in Mathematics)

MATH 225S: Vector Analysis, Differential Equations and Transforms

Objective
The aim of this course is to make the students acquire facility and confidence in the use of vectors and vector calculus so that they may employ the same in an effective manner to various applications and to exhibit the techniques of solving ordinary and partial differential equations.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I


Homogeneous and nonhomogeneous ordinary differential equations of second order with constant co-efficients. Wronskian and Linear independence and dependence of solution, particular integral, D-operator method, method of variation of parameters.

PART-II
The Laplace transforms, shifting theorem. The convolution theorem. Inverse transform. Applications to ordinary differential equations.

Legendre polynomials. Their recurrence and orthogonal relations.

Formation of first and second order partial differential equations, solutions of first order equation, classification of linear second order equations, separation of variables, solution of one-dimensional wave and heat equations, solution of Laplace equation.

[Scopec as in Sections 4.5-4.7, 5.1, 5.2, 5.3.1, 5.3.2, 5.4.1, 5.4, 8.1-8.4, 8.5.4, 7.2, 16.2, 16.3.1, 9.5.1, 9.5.2, 9.5.3, 9.5.4, 9.5.5 of Ref.4.]

Suggested Readings

(For students with background in Mathematics)

MATH 235S : Integral Transforms and Complex Analysis

[6 hrs per week]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
To acquaint the students with the application of Laplace transforms to solve ordinary differential equations. Moreover, basics of Complex Analysis are also included in this course.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART- I: Laplace Transforms


PART-II: Complex Analysis

Complex numbers, absolute value, argument. Functions $e^z$, sin $z$, cos $z$, log $z$ and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions and their conjugates.

Integration of complex functions, Cauchy’s theorem (statement only), Cauchy’s theorem for multiply connected domains (statement only). Cauchy’s integral formula (statement only) and simple consequences.

Expansion into Laurent series, singularities, Residues, Cauchy residue theorem (statement only). Evaluation of definite integrals using contour integration.

[Scope as in relevant sections of Chapter 1-6 of Ref. 4.]

Suggested Readings
OUTLINES OF TESTS, SYLLABI AND COURSES OF READING IN THE SUBJECT OF ECONOMICS (SUBSIDIARY) FIRST AND SECOND YEAR FOR B. Sc. (HONOURS SCHOOL) MATHEMATICS FOR THE EXAMINATIONS OF 2012-2013.

(ECONOMICS SUBSIDIARY)

FIRST YEAR – MIC macroECONOMICS
SEMESTER – 1

Max. Marks: 80 Time: 3 Hrs.

Internal Assessment: 20

Instructions for Paper-setter and candidates:

1. The syllabus has been divided into four units.
2. There shall be 9 questions in all.
3. The first question, which would be compulsory, shall be short answer type (word limit 125 each). It would carry 16 short questions, spread over the whole syllabus. The candidate will be required to attempt any 8 short answer type questions. Each short answer type question would carry two marks (2x8 = 16).
4. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidates shall be required to attempt one question from each Unit – 4 in all. Each question shall carry 16 marks (16x4 = 64)

UNIT – I

Definitions of Economics: Marshall and Robbins. Distinction between micro and macroeconomics, positive and normative economics, deductive and inductive method of economic analysis, partial and general equilibrium.

UNIT - II


UNIT – III

Production analysis: Law of Variable Proportions, concept of a homogeneous production Function (Cobb-Douglas only) and its properties, laws of returns to scale. Deriving cost function from production function, short run and long run cost curves, economies and diseconomies of scale.
UNIT – IV

Concept of supply curves and supply elasticities, Interaction between demand and supply, comparative statics of price determination, Cobweb theorem.

SELECTED READINGS

R G Lipsey (1975) : Introduction to Positive Economics.
SEMESTER – II

FIRST YEAR – MICROECONOMICS

Max. Marks: 80  Time: 3 Hrs.
Internal Assessment: 20

Instructions for Paper-setter and candidates:

1. *The syllabus has been divided into four units.*
2. There shall be 9 questions in all.
3. The first question, **which would be compulsory**, shall be short answer type (word limit 125 each). It would carry 16 short questions, spread over the whole syllabus. The candidate will be required to attempt any 8 short answer type questions. Each short answer type question would carry **two** marks (2x8 = 16).
4. Rest of the paper shall contain 4 units. Each unit shall have **two** questions and the candidates shall be required to **attempt one question** from each Unit – 4 in all. Each question shall carry 16 marks (16x4 = 64)

UNIT – I

Definition of a market, basic elements of a market structure, equilibrium of a competitive firm in the short run and long run. Monopoly, definition and pricing in the short run and long run.

UNIT – II

Introduction to discriminating Monopoly, Product differentiation, Advertisement and selling costs, short run equilibrium of a firm under monopolistic competition.

UNIT – III

Marginal productivity theory of distribution with special reference to wage determination. Homogeneous production function and Euler’s theorem. Ricardian and modern theory of rent, concept of quasi rent.

UNIT – IV

Classical savings, investment and liquidity preference theory of interest. Schumpeter’s theory of profits, Knight’s theory of Risk, uncertainty and profits.
SELECTED READINGS

R G Lipsey (1975) : Introduction to Positive Economics.


SECOND YEAR – MACROECONOMICS

SEMESTER – III

Max. Marks: 80

Internal Assessment: 20

Instructions for Paper-setter and candidates:

1. The syllabus has been divided into four units.

2. There shall be 9 questions in all.

3. The first question, which would be compulsory, shall be short answer type (word limit 125 each). It would carry 16 short questions, spread over the whole syllabus. The candidate will be required to attempt any 8 short answer type questions. Each short answer type question would carry two marks (2x8 = 16).

4. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidates shall be required to attempt one question from each Unit – 4 in all. Each question shall carry 16 marks (16x4 = 64).

UNIT – I

Introduction to National Income Accounting, Alternative methods of estimating National Income and other Aggregates; estimation through numerical examples; problems encountered in national income estimation. From Macro economic accounting to Macro economic theory.

UNIT – II

Basic concepts of Macroeconomics: employment, price level, investment, savings. Balance of payments; Concepts of stocks and flows. Income, output and employment determination in the classical model; Say’s law.

UNIT – III

Concept of effective demand: consumption spending, consumption function, APC, MPC, Determination of output and Income in the Simple Keynesian Model.
UNIT – IV

Underemployment equilibrium and Keynesian solution. Concept and operation of multiplier.

SELECTED READINGS


SEMESTER – IV

SECOND YEAR – MACROECONOMICS

Max. Marks: 80       Time: 3 Hrs.
Internal Assessment: 20

Instructions for Paper-setter and candidates:

1. The syllabus has been divided into four units.

2. There shall be 9 questions in all.

2. The first question, which would be compulsory, shall be short answer type (word limit 125 each). It would carry 16 short questions, spread over the whole syllabus. The candidate will be required to attempt any 8 short answer type questions. Each short answer type question would carry two marks (2x8 = 16).

3. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidates shall be required to attempt one question from each Unit – 4 in all. Each question shall carry 16 marks (16x4 = 64).

UNIT-I

Investment: Autonomous and Induced; determinants of investment spending, extension of the simple Keynesian model, IS-LM.

UNIT – II

Stabilization policies: Monetary and Fiscal policies in a closed economy, Multiplier – Accelerator Interaction: Trade cycle theories with reference to Hicksian trade cycle model.

UNIT – III

Definition, functions and demand for money; commercial banks, credit creation and supply of Money.

UNIT – IV

Inflation: measure, theories (cost-push and demand-pull) and control of inflation. Role of Central Bank.
SELECTED READINGS

Rowan, D C (1974) : Output, Inflation and Growth, 2\textsuperscript{nd} Edition

Shapiro, Edward (1998) : Macro Economics, 5\textsuperscript{th} Edition,
Galotia Publications


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OUTLINES OF TESTS, SYLLABI AND COURSES OF READING IN THE SUBJECT OF PHILOSOPHY (SUBSIDIARY) FIRST AND SECOND YEAR FOR B.SC. (HONS. SCHOOL) MATHEMATICS FOR THE EXAMINATIONS OF 2012-2013.

PHILOSOPHY (SUBSIDIARY) 1st YEAR

ELEMENTARY PHILOSOPHY

SEMESTER I

Max. Marks : 80
Int. Ass. : 20
Total Marks : 100
Time : 3 hours.

Aims and Objectives. The aim of this paper is to familiarize the students with the subject, its main branches, problems and methods. The content of this paper provides the students with a wider canvas about tackling day to day problems from larger perspective.

INSTRUCTIONS FOR THE PAPER-SETTER AND THE CANDIDATES.

There shall be 9 questions in all. The first question shall be short answer type containing 15 short questions spread over the whole syllabus and each to be answered in about 25 to 30 words. The candidate is required to attempt any 8 short answers type questions i.e. 2 marks of each. It shall carry 16 marks and shall be compulsory question. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidate shall be given internal choice i.e. the candidate shall attempt one question from each unit-4 in all of 16 marks each.

UNIT I

1. a. A General introduction to the Nature and Scope of Philosophy, Indian and Western Perspective.

   b. Relation of Philosophy to Science and Religion.

   UNIT II


   b. Plato and Aristotle in Western Philosophy.

   c. Chandogya Upanishad and Buddha in Indian Philosophy.

   UNIT III


   b. Ethics and Moral Life.
UNIT IV

4. a. What is Idealism
    b. Different types of Idealism
    c. Implications of idealism

SEMESTER II

Max. Marks : 80
Int. Ass. : 20
Total Marks : 100
Time : 3 hours

Aims and Objectives. The aim of this paper is to familiarize the students with the subject, its main branches, problems and methods. The content of this paper provides the students with a wider canvas about tackling day to day problems from larger perspective.

INSTRUCTIONS FOR THE PAPER-SETTER AND THE CANDIDATES.

There shall be 9 questions in all. The first question shall be short answer type containing 15 short questions spread over the whole syllabus and each to be answered in about 25 to 30 words. The candidate is required to attempt any 8 short answers type questions i.e. 2 marks of each. It shall carry 16 marks and shall be compulsory question. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidate shall be given internal choice i.e. the candidate shall attempt one question from each unit-4 in all of 16 marks each.

UNIT I

1. a. Logic, Reason and Reality
    b. Thought and Language
    c. Universals and Particulars

UNIT II

2. a. Religious Experience.
    b. Idea of God.
UNIT III

   b. Theories of Art.
   c. Aesthetic Experience.

UNIT IV

4. a. Philosophy of Culture.
   b. Meaning and origin of Culture.
   c. Tradition and Modernity.

Essential Readings


Suggested Readings


M. Hiryanna Outlines of Indian Philosophy Published by M/s Kayalaya Publishers. Delhi 1993.
Aims & Objectives: The paper aims at training the students in skills of critical reasoning by introducing laws of thought, criteria for validity of arguments, deductive and inductive reasoning.

INSTRUCTIONS FOR THE PAPER SETTER AND THE CANDIDATES.

(i) The theory question paper will be 80 marks and 20 marks will be for internal assessment.

(ii) There shall be 9 questions in all. The first question shall be short answer type containing 15 short questions spread over the whole syllabus and each to be answered in about 25 to 30 words. The candidate is required to attempt any 10 short answer type questions i.e. 2 marks of each. It shall carry 20 marks and shall be Compulsory question. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidates shall be given internal choice i.e. the candidates shall attempt one question from each Unit – 4 in all.

Unit – I

Logic, Language and Thought, Definition of Proposition and Classification, Square of Opposition of Propositions and its Boolean Modification.

Inference and Argument, Validity of Argument, Types of Inference – Immediate and Mediate (Syllogism).

Unit – II

Immediate Inference – Conversion, Obversion, Contraposition, Inversion and inference from Relation of opposition between propositions.

Syllogism – Its Rules or Axioms and Fallacies, Figures and Moods of Syllogism, general theorems of Syllogism and special theorems of each figure, Types of Syllogism – Enthymeme and Sorites, Test of Syllogism – Antilogism

Unit – III

Formalization of Language, Symbolization of propositions, Classification of Proposition according to structure – Simple and Compound, Classification of proposition according to Truth-Value – Tautology, Contradiction and contingency.
Truth Function, Prepositional Form, Argument and Argument Form, Rules of Inference and Rules of Replacement.

**Unit – IV**


Induction and Probability, Subjective and Objective Theories of Probability, Calculus of Probability.

**SEMESTER IV**

| Max Marks | 80 |
| Int. Ass. | 20 |
| Total Marks | 100 |
| Time | 3 Hours |

**Aims & Objectives:** The paper aims at training the students in skills of critical reasoning by introducing laws of thought, criteria for validity of arguments, deductive and inductive reasoning.

**INSTRUCTIONS FOR THE PAPER-SETTER AND CANDIDATES**

(i) The theory question paper will be 80 marks and 20 marks will be for internal assessment.

(ii) There shall be 9 questions in all. The first question shall be short answer type containing 15 short questions spread over the whole syllabus and each to be answered in about 25 to 30 words. The candidate is required to attempt any 10 short answer type questions i.e. 2 marks of each. It shall carry 20 marks and shall be **Compulsory** question. Rest of the paper shall contain 4 units. Each unit shall have two questions and the candidates shall be given internal choice i.e. the candidates shall attempt one question from each Unit – 4 in all.

**Unit – I**


Proof of Invalidity of Argument – Shorter Truth – Table method.
Unit – II
Symbolization of General Propositions (singly general and multiply general propositions), Rules of Quantification.
Proofs of Validity and Invalidity of Arguments involving General Propositions.

Unit – III
Boolean Normal Forms, Identification of Formulas as – Tautologies, Contradiction and Contingency.

Unit – IV
Mill’s Methods of Experimental Inquiry – Criticism of the methods of Agreement, Difference, Joint method, Method of Concomitant variation and method of Residue.

Essential Readings
1. Irving M. Copi : Introduction to Logic.

Further Readings
2. Jean Necod : Foundation of Geometry and Induction (Kegan Paul).

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OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.SC. (HONS. SCHOOL) IN MATHEMATICS FOR SEMESTER I AND SEMESTER II EXAMINATIONS 2012-2013

Outlines of Tests

1. Every student will have to take five papers.
2. Each paper/course shall carry 100 marks.
3. The duration of the examination shall be of three hours.
4. The question paper will have two parts each having four questions. Candidates will attempt five questions in all choosing at least two from each part.
5. All questions carry equal marks

Semester I

Every student will have to take five papers given below:

Paper I: Math 701S – Topology
         OR
         Math 702S – Real Analysis

Paper II: Math 703S - Topics in Algebra-I
          OR
          Math 704S – Groups and Rings

Paper III: Math 705S - Linear Programming
           OR
           Math 706S - Number Theory-I

Paper IV: Math 707S – Complex Analysis-I


The above mentioned courses will be offered to the students depending upon their background.
Semester-II

Paper I: Math 721S - Functional Analysis
OR
Math 722S - Measure Theory

Paper II: Math 723S - Topics in Algebra-II
OR
Math 724S - Modules & Fields

Paper III: Math 725S - Non-Linear Programming
OR
Math 726S - Number Theory-II

Paper IV: Math 727S - Complex Analysis-II

Paper V: Math 728S - Classical Mechanics-II

The students who have studied Courses – MATH 701S, MATH 703S, MATH 705S in Semester I will have to take MATH 721S, MATH 723S, MATH 725S in Semester II.

Students who have studied MATH 702S, MATH 704S, MATH 706S in Semester I will have to take MATH 722S, MATH 724S, MATH 726S in Semester II
Semester-I

Paper-I

MATH-701S: Topology

[7 hrs per week(including tutorials)]

[Max.Marks:100]

(Final-80+Internal Assessment-20)

Time : 3hrs

Objectives

The course is an introductory course on point-set topology so as to enable the reader to understand further deeper topics in topology like Differential/Algebraic Topologies etc.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART – I

Topological Spaces, bases for a topology, the order topology, the product topology on \( X \times Y \), the subspace topology, closed sets and limit points, continuous functions, the product topology, the metric topology, the quotient topology.


Connected spaces, connected subspaces of the real line, components and local connectedness

PART – II

Compact spaces, compact space of the real line, limit point compactness, local compactness, nets.


The countability axioms, the separation axioms, normal spaces, the Urysohn Lemma, the Urysohn Metrization Theorem, the Tietze Extension Theorem, the Tychonoff Theorem.


References:


OR

MATH 702S : Real Analysis

[7 hrs per week(including tutorials)]
[Max.Marks:100]
(Final-80+Internal Assessment-20)
Time : 3hrs

Objective
The aim of this course is to make the students learn fundamental concepts of metric spaces, The Riemann-Stieltjes integral as a generalization of Riemann Integral, the calculus of several variables and basic theorem.

Note : 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

PART-I

(i) Basic Topology: Finite, countable and uncountable sets, metric spaces, compact sets, perfect sets, connected sets.

(ii) Sequences and series: Convergent sequences, subsequences, Cauchy sequences(in metric spaces), completion of a metric space, absolute convergence, addition and multiplication of series, rearrangements of series of real and complex numbers.

(iii) Continuity: Limits of functions (in metric spaces), continuous functions, continuity and compactness, continuity and connectedness, monotonic functions.


PART II

(v) Sequences and series of functions: Problem of interchange of limit processes for sequences of functions, Uniform convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, equicontinuous families of functions, Stone Weierstrass Theorem.
(vi) Differentiation: Differentiation of vector-valued functions.

(vii) Functions of several variables: The space of linear transformations on \( \mathbb{R}^n \) to \( \mathbb{R}^m \) as a metric space. Differentiation of a vector-valued function of several variables. The Inverse function theorem. The implicit function theorem

**Scope**

For items (i) to (vii) as in relevant sections of Chapters 2 to 7 and Chapter 9 of the book at Sr. No. 6 in the list of references.

**References:**

Paper-II

MATH 703S : Topics in Algebra-I

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs

Objective
The objective of this course is to introduce the basic ideas of field theory and Galois Theory and to see its application to the solvability of polynomial equations by radicals. Answers to some classical problems of ancient Greeks regarding the ruler and compass constructions shall be obtained as a consequence of the development of the subject. This course also provides the foundation required for more advanced studies in Algebra. The aim is also to develop necessary prerequisites for Math 723S.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Field Theory:


PART-II


Review of Rings and ring homomorphism, ideals, quotient rings, zero divisors, nilpotent elements, units, prime ideals and maximal ideals, Nilradical and Jacobson radical, operation on ideals, extension and contraction of ideals, Modules and module homomorphisms, submodule and quotient module, operation on submodules, direct sum and product, finitely generated modules, exact sequences, tensor product of modules, restriction and extension of scalars, exactness property of the tensor product, Algebras, tensor product of algebras.

References

6. Gopalakrishnan, N.S., Commutative Algebra, Oxonian Press (New Delhi) 1984


OR

MATH-704S: Groups and Rings

[7 hrs/week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs

Objective
This course covers some advanced topics of Group Theory and Ring Theory, which are two most important branches of algebra.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Review of Permutation Groups, Simplicity of $A_n \ (n \geq 5)$, Sylow Theorems, Direct Products, finite Abelian Groups, Fundamental Theorem on Finite Abelian Groups, Normal and Subnormal Series, Derived Series, Composition Series, Solvable Groups, Zassenhaus Lemma and Jordan-Holder Theorem.

PART-II

Review of Rings, Zero Divisors, Nilpotent Elements and Idempotents, Matrices, Quaternions, Ring of endomorphisms, polynomial rings in many variables, Factorization of polynomials in one variables over a field. Unique factorization domains. Gauss Lemma, Eisenstein’s Irreducibility Criterion, Unique Factorization in $R[x]$ where R is a Unique Factorization Domain. Euclidean and Principal ideal domains (scope as in chapters 1, 2, 4, 8, 9 of Luthar & Passi).

References:
Paper-III

MATH 705S : Linear Programming  
[7 hrs per week (including tutorials)]  
Max.Marks : 100  
[Final-80+Internal Assessment-20]  
Time: 3hrs.

Objective

The objective of this course is to acquaint the students with the concept of convex sets, their properties and various separation theorems so as to tackle with problems of optimization of functions of several variables over polyhedron and their duals. The results, methods and techniques contained in this paper are very well suited to the realistic problems in almost every area.

Note:  1. The question paper will have eight questions. Candidates will attempt five questions.
   2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
   3. All questions carry equal marks.

PART-I


PART-II


[Scope as in Chapter 2-5; Chapter 7-9 of the reference no.1, chapter 4-6 of reference no3, chapter 5 of reference no2].

References:

OR

MATH 706S: Number Theory-I

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective:

The aim of this course is to teach the students about the basics of Elementary Number Theory starting with primes, congruences, quadratic residues, primitive roots, arithmetic functions. Apart from teaching the theory, stress will be on solving problems.

Note:
1. The question paper will consist of two parts containing four questions each. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Divisibility, Greatest common divisor, Euclidean algorithm, The Fundamental theorem of arithmetic, Congruences, Residue classes and reduced residue classes, Chinese remainder theorem, Fermat’s little theorem, Wilson’s theorem, Euler’s theorem and its application to cryptography, Arithmetic functions \( \phi(n), \ d(n), \ \sigma(n), \ \mu(n) \), Mobius inversion formula, Greatest integer function.

PART-II

Primitive roots and indices. Quadratic residues, Legendre symbol, Euler’s criterion, Gauss’s lemma, Quadratic reciprocity law, Jacobi symbol. Representation of an integer as a sum of two and four squares. Diophantine equations \( ax + by = c \), \( x^2 + y^2 = z^2 \), \( x^4 + y^4 = z^2 \). Binary quadratic forms and equivalence of quadratic Forms. Perfect numbers, Mersenne primes and Fermat numbers, Farey fractions.

References:
Paper-IV

MATH 707S: Complex Analysis-I

[7 hrs per week (including tutorials)]
Max. Marks: 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
The objective of the course is to provide foundation for other related branches of Mathematics. Most of the topics covered are widely applicable in Applied Mathematics and Engineering. Moreover, while designing the syllabus, the syllabus of UGC NET was also considered.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Complex plane, geometric representation of complex numbers, joint equation of circle and straight line, stereographic projection and the spherical representation of the extended complex plane. Topology on the complex plane, connected and simply connected sets. Complex valued functions and their continuity. Curves, connectivity through polygonal lines.

Analytic functions, Cauchy-Riemann equations, Harmonic functions and Harmonic conjugates. Power series, exponential and trigonometric functions, arg $z$, log $z$, $e^z$ and their continuous branches. Complex Integration, line integral, Cauchy’s theorem for a rectangle, Cauchy’s theorem in a disc.

(Scope as in “Theory of Functions of a Complex Variable” by Shanti Narain).

PART-II

Index of a point with respect to a closed curve, Cauchy’s integral formula, higher derivatives, Morera’s theorem, Liouville’s theorem, fundamental theorem of Algebra, Maximum Modules principle, Schwarz Lemma. The general form of Cauchy’s theorem. Taylor series and Laurent series. Singularities, Cauchy’s residue theorem and Calculus of residues.

(Scope as in “Complex Analysis” by D. V. Ahlfors, Chapter 4, §1, 2 §4.1 to 4.5 and §5.1 and the book “Theory of Functions Complex Variable” by Shanti Narain, and in “Theory of Functions Complex Variable” by Shanti Narain, Chapter 1, 2, §39-44 and §47-50, 53, 54 of Chapter 4, §59-64 of Chapter 5., §79-88 of Chapter 6, §111-113, §117-118 of Chapter 9 and Chapter 11)

References:


**Paper-V**

**MATH 708: Classical Mechanics-I**

[7 hrs per week (including tutorials)]

Max.Marks : 100

[Final-80+Internal Assessment-20]

Time: 3hrs.

**Objective**
The objective of this paper is to introduce the concept of variation of a functional and variational techniques. The Calculus of variation helps a lot to understand the Lagrangian and Hamiltonian equations for dynamical systems. Variational principles and their applications are introduced at large

**Note:**
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

**PART-I**

**Calculus of variations:** Functional and their properties, Motivating problems of Calculus of variations, Shortest distance, minimum surface of revolution, Brachistochrone problem, Isoperimetric problems, Geodesics, Fundamental lemma of Calculus of Variations, Euler’s equation for one dependent function and its generalization to (i) n dependent functions, (ii) higher order derivatives, Variational problems with moving boundaries, Variation under constraints, Variational methods of Rayleigh-Ritz and Galerkin.
**Lagrangian Mechanics:** Generalized coordinates, Constraints, Holonomic and non-holonomic systems, Scleronomic and Rheonomic systems, Generalized velocity, Generalized potential, Generalized force, D’Alembert’s principle, Lagrange’s equation, Velocity dependent Potentials and Dissipation function, Expression of Kinetic energy using generalized velocity, Non-uniqueness in the choice of Lagrangian.

**PART-II**

**Lagrangian Mechanics:** Hamilton’s principle, Principle of Least action, Derivation of Lagrange’s equations from Hamilton’s principle, Cyclic co-ordinates, Conjugate momentum, Conservation theorems.

**Hamiltonian Mechanics:** Legendre’s transformation, Hamilton’s equations, Routhian, Poisson Bracket, Jacobi identity for Poisson bracket, Poission theorem, Hamilton’s equation in Poission bracket, Canonical Transformation, Hamilton-Jacobi equations, Method of Separation of variables, Action – Angle variables, Lagrange Bracket. Invariance of Lagrange Bracket under Canonical Transformations.

**References:**

1. L. Elsgolts: Differential equations and the calculus of variations, Mir Publication
Semester-II

Paper-I

MATH 721S: Functional Analysis

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
The objective of this course is to introduce Banach and Hilbert spaces. The various operators on Hilbert and Banach spaces are also included.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
   2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
   3. All questions carry equal marks.

PART-I

Baire Category theorem and its applications.
[Scope as in relevant topics of Chapter I from Ref.2]

Nomed Spaces, with examples of Function spaces $L^p([a,b])$, $C([a,b])$ and $C^1([a,b])$, Sequence Spaces $l^p$, $c$, $c_0$, $c_{00}$, Banach Spaces Hahn Banach theorem, open mapping theorem, closed graph theorem, Banach Steinhauns theorem (uniform boundedness principle), [Scope as in relevant topics from Chapter 2 & 3 of Ref.6.]

PART-II


Bounded Operators on Hilbert spaces: Bounded operators and adjoints; normal, unitary and self adjoint operators, Spectrum and Numerical Range.
[Scope as in Ch.VI & VII (§25-27.7) of the book ‘Functional Analysis’ by B.V.Limaye, 1996.]

References:


OR
MATH 722S: Measure Theory

Max. Marks: 100

[7 hrs per week (including tutorials)]

Objective
The objective of this course is to study Lebesgue measure as generalisation of lengths, Lebesgue integral, Fundamental Theorem of Calculus and $L^p$ spaces.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

(i) Lebesgue measure: Introduction, outer measure, measurable sets and Lebesgue measure, a non-measurable set, measurable functions, Littlewood's three principles.

(ii) The Lebesgue Integral: The Lebesgue integral of a bounded function over a set of finite measure, the integral of a non-negative function, the general Lebesgue integral, convergence in measure.

PART-II

(iii) Differentiation and Integration: Differentiation of monotone functions, differentiation of an integral, absolute continuity, convex functions.


Scope
For items (i) to (iv) as in relevant sections of Chapters 3 to 6 of the book at Sr.No. 3 of references.

References:
Paper-II

MATH 723S: Topics in Algebra-II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
Commutative Algebra is the study of commutative rings, their modules and ideals. This theory has developed over the last 150 years not just as an area of algebra considered for its own sake, but as a tool in the study of two enormously important branches of mathematics: algebraic geometry and algebraic number theory. This course will give the student a background in commutative algebra which is used in both algebraic geometry and number theory.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Rings and Modules of fractions, local properties, extended and contracted ideals in ring of fractions, Primary Decomposition, Integral dependence, The going up theorem, Integrally closed domains, The going down theorem, valuations rings, (Scope as in Chapters III - V of M.F.Atiyah and I.G.Macdonald).

PART-II

Chain conditions, Noetherian rings, Primary decomposition in Noetherian rings, Artin rings (Scope as in Chapters VI-VIII of M.F.Atiyah and I.G.Macdonald).

REFERENCES

MATH 724S : Modules and Fields

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course is a basic course in Algebra for students who wish to pursue research work in Algebra. Contents have been designed in accordance with the UGC syllabi in mind.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Modules, Submodules, Quotient Modules, Free Modules, Difference between Modules and Vector Spaces, Homomorphisms, Simple Modules, Structure Theorem for submodules of a f.g. free module over a P.I.D., Invariance theorem for elementary divisors of a f.g. module over a P.I.D, Artinian and Noetherian Modules

Fields, examples, characteristic of a field. Algebraic extensions, The degree of a field extension, Adjunction of roots, splitting fields, finite fields, Algebraically closed fields,

PART-II

Separable and purely inseparable extensions. Perfect fields, primitive elements. Langrange’s theorem on primitive elements, normal extensions, Galois extensions, the fundamental theorem of Galois theory. Cyclotomic extensions. Cyclic extensions, Quintic equations and solvability by radicals.

References:
Paper-III

MATH 725S : Non-Linear Programming

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
To acquaint the students with the concepts of convex and non-convex functions, their properties, various optimality results, techniques to solve nonlinear optimization problems and their duals over convex and non-convex domains and also with the game theory.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Nonlinear Programming: Convex functions, Concave functions, Definitions and basic properties, subgradients of convex functions, Differentiable convex functions, Minima and Maxima of convex function and concave functions. Generalizations of convex functions and their basic properties.

Unconstrained problems, Necessary and sufficient optimality criteria of first and second order. First order necessary and sufficient Fritz John conditions and Kuhn-Tucker conditions for Constrained programming problems with inequality constraints, with inequality and equality constraints. Kuhn Tucker conditions and linear programming problems.

PART -II

Duality in Nonlinear Programming, Weak Duality Theorem, Wolfe’s Duality Theorem, Hanson-Huard strict converse duality theorem, Dorn’s duality theorem, strict converse duality theorem,
Dorn’s Converse duality theorem, Unbounded dual theorem, theorem on no primal minimum.
Duality in Quadratic Programming.

Quadratic programming: Wolfe’s method, Beale’s method for Quadratic programming.

Linear fractional programming, method due to Charnes and Cooper. Nonlinear fractional
programming, Dinkelbach’s approach.

Game theory - Two-person, Zero-sum Games with mixed strategies, graphical solution, solution
by Linear Programming.

[Scope as in Chapter 17 of reference no.4, Chapter 3 & 4 of reference no.1, chapter 24, 26 and 28
of reference no2, Chapter 8 of reference no3, chapter 16 of reference no5]

References:

3. O. L. Mangasarian: Nonlinear Programming, TATA McGraw Hill Company Ltd. (Bombay,

OR

MATH 726S: Number Theory-II

[7 hrs per week (including tutorials)]
Max. Marks: 100
[Final-80+Internal Assessment-20]
Time: 3 hrs.

Objective

The objectives of this course is to teach the fundamentals of different branches of Number Theory,
namely, Geometry of Numbers, Partition Theory and Analytic Number Theory.

Note:
1. The question paper will consist of two parts containing four questions each. Candidates
   will attempt five questions.
2. There will be four questions from each part and the students will be required
to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Continued fractions, Approximation of reals by rationals, Pell’s equations, Partitions, Ferrers
graphs, Jacobi’s triple product identity, Congruence properties of \( p(n) \), Rogers-Ramanujan
identities, Minkowski’s theorem in geometry of numbers and its applications to Diophantine
inequalities.
PART-II

Order of magnitude and average order of arithmetic functions, Euler’s summation formula, Abel’s identity, Elementary results on distribution of primes. Characters of finite Abelian groups, Dirichlet’s theorem on primes in arithmetical progression.

References:

Paper-IV

MATH 727S : Complex Analysis-II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course is designed to provide follow up to Course No.707S. This course will provide basic topics needed for students to pursue research in pure Mathematics. Most of the topics mentioned in UGC NET have also been included.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I


PART -II

Analytic Continuation through power series (basic ideas), Natural boundary, the Gamma function and Riemann Zeta function. Elliptic functions
(Scope as in “Complex Analysis” by D. V. Ahlfors Chapter 5 §2.3, 2.4, 4.1, 4.2, Chapter 7§1 to 3.3 and in “Theory of Functions Complex Variable” by Shanti Narain, Chapter 3, §65-67 of Chapter 5, Chapter 7 §120-129 of Chapter 10).

References:
Paper-V

MATH 728S: Classical Mechanics-II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This Course is developed to understand the motion of celestial bodies and dynamics of rigid bodies. Introduction to elasticity and elastic waves are incorporated keeping in view their applications in various fields of science and engineering.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Central force motion: Central force, Equivalent one-body problem, Motion in a central force field, General features of the motion: Motion in arbitrary potential field, Motion in a inverse square law, Differential equation of orbit, Classification of orbits, Bertrand’s theorem.

Rigid Body Dynamics: Moments and product of inertia, Theorems of Parallel and Perpendicular axes, M.I. of thin rod, Rectangular lamina, Rectangular parallelopiped, Circle, Circular disc, Hollow and Solid spheres, Cone etc. Principal axis and examples, Kinetic energy of body rotating
about a fixed point, Euler’s dynamical equations for motion of rigid body, Solution for symmetrical body, Symmetrical top, Steady motion of Symmetrical top and its Stability, Eulerian angles.

**PART- II**

**Elastodynamics:** Analysis of Deformation tensor, Stresses and condition of equilibrium, Hooke’s Law and Strain energy function, Simple cases of strain and stress and equation of motion, Waves in isotropic elastic medium, Waves of dilatation and distortion, Plane waves, Surface waves-Rayleigh and Love waves. Frequency equation of an oscillating sphere, P, SV and SH waves, Reflection of P and SH waves from stress free boundary surface of a uniform elastic half-space.

**References:**

OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR M.SC. (HONS. SCHOOL) IN MATHEMATICS SEMESTER III & IV FOR THE ACADEMIC SESSION 2012-2013

Outlines of Tests


Semester III

1. Math 705S: Linear Programming
2. Math 751S: Topology
3. Math 752S: Linear Algebra and Commutative Algebra-I
4. Math 761S: Computational Techniques-I
5. Math 771S: Algebraic Number Theory-I
6. Math 772S: Topics in Number Theory-I
8. Math 774S: Algebraic Coding Theory-I
9. Math 775S: Non-Commutative Ring Theory

Semester IV

1. Math 725S: Non-Linear Programming
2. Math 770S: Functional Analysis
3. Math 769S: Commutative Algebra-II
4. Math 781S: Computational Techniques-II
5. Math 791S: Algebraic Number Theory-II
6. Math 792S: Topics in Number Theory-II
7. Math 793S: Fluid Mechanics-II
8. Math 794S: Algebraic Coding Theory-II
10. Math 796S: Partial Differential Equations-II
11. Math 797S: Continuum Mechanics-II
Semester-III

MATH 705S : Linear Programming

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
The objective of this course is to acquaint the students with the concept of convex sets, their properties and various separation theorems so as to tackle with problems of optimization of functions of several variables over polyhedron and their duals. The results, methods and techniques contained in this paper are very well suited to the realistic problems in almost every area.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I


PART-II


[Scope as in Chapter 2-5; Chapter 7-9 of the reference no.1,chapter 4-6 of reference no3, chapter 5 of reference no2].

References:
MATH-751S: Topology

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objectives
The course is an introductory course on point-set topology so as to enable the reader to understand further deeper topics in topology like Differential/Algebraic Topologies etc.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer atleast two questions from each part.
3. All questions carry equal marks.

PART – I

Topological Spaces, bases for a topology, the order topology, the product topology on $X \times Y$, the subspace topology, closed sets and limit points, continuous functions, the product topology, the metric topology, the quotient topology, Sequence, Nets and Filters

Connected spaces, connected subspaces of the real line, components and local connectedness


PART – II

Compact spaces, compact space of the real line, limit point compactness, local compactness, nets.

The countability axioms, the separation axioms, normal spaces, the Urysohn Lemma, the Urysohn Metrization Theorem, the Tietze Extension Theorem, the Tychonoff Theorem.


References:
Objective
The objectives of this course is to develop a strong foundation in linear Algebra that provide a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc. Particular attention to canonical forms of linear maps, matrices, bilinear forms and quadratic forms is given. The aim is to develop necessary prerequisites for Math 769S.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Linear Algebra: Eigenvalues and eigenvectors, eigenspaces and similarity, representation by a diagonal matrix; linear functionals, real quadratic forms, orthogonal matrices, reduction of real quadratic forms, classification of real quadratic forms, bilinear forms, symmetric bilinear forms, hermitian forms; inner product spaces, norms and distances, orthonormal bases, orthogonal complements, isometries, normal matrices, normal linear operators.

PART-II
Projections and direct sums, spectral decompositions, minimal polynomials and spectral decompositions, nilpotent transformations, the Jordan canonical form.

Commutative Algebra: Rings and ideals, modules, tensor products of modules.

References
4. Gopalakrishnan, N.S., Commutative Algebra, Oxonian Press (New Delhi) 1984
MATH 761S: Computational Techniques –I

**Theory**

[4 hrs per week (including tutorials)]
Max. Marks: 80
[Final-60+Internal Assessment-20]
Time: 3hrs.

**Objective**
The objective of this course is to teach the basics of computer and computer programming so that one can develop the computer program in FORTRAN at their own. For the purpose of learning programming skill, some Numerical methods which are extremely useful in scientific research are included. For practising the programmes of the numerical method, the course of practical has also been included in this paper. The contents of the curriculum have been designed keeping in view the UGC guidelines.

**Note:**
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.
4. Use of scientific calculator is allowed for numerical work.

**PART – I**

FORTRAN77: Character set, constants, variables, Arithmetic expressions, Library functions, Arithmetic statements, Structure of a FORTRAN Program, FORMAT specifications, READ and WRITE statements, Simple programs, Control statements: GO TO, IF, IF-THEN-ELSE and ELSE-IF-THEN statements, DO loop, Nested DO loop, CONTINUE statement, DATA statement, DOUBLE precision, LOGICAL data, WHILE structure, Arrays and Subscripted variables, Implied DO loop, One and multi-dimensional arrays, Sub programs: Function subprogram and Subroutine subprogram, OPEN a file, Read from a file, Write in a file.

**PART – II**

Solution of non-linear equations: Bisection, Regula-falsi, Secant, Newton-Raphson, Generalized Newton’s method, Chebyshev Formula of third order, Halley’s methods, Functional iteration, Muller’s methods, Convergence analysis of these methods, Comparison of these methods, Simultaneous non-linear equations by Newton-Raphson method, Lin- Bairstow’s and Newton’s method for complex roots.

Interpolation: Finite differences, Newton’s formulae for interpolation, Lagrange and Hermite interpolation, Cubic Spline interpolation.

Numerical integration-Trapezoidal, Simpson’s, Boole’s, Weddle’s rule, Error in Integration formulae, Double Integration, Truncation errors in Trapezoidal and Simpson’s rules.
Computational Techniques (Practical)-I

[3 hrs per week, Max. Marks: 20]

Writing programs in FORTRAN for the problems based on the method studied in theory paper and run them on PC.

Practical shall be conducted by the department as per the following distribution of marks:

- Writing program in FORTRAN and running it on PC=10 Marks
- Practical record=5 Marks
- Viva-Voice=5 Marks

References:


*NOTE: There will be no internal assessment in the Practical examination.

MATH: 771S: Algebraic Number Theory-I

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course is an introduction to algebraic number theory which is a subject that originated as a result of the attempts to solve Fermat's Last Theorem. Algebraic number theory is an active area of research in mathematics.

Note:  
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Algebraic number fields and their rings of integers, Integral bases, Discriminant, Explicit consideration of quadratic, cyclotomic and special cubic fields. Properties of norm of ideals in the ring of algebraic integers, Factorization of ideals into prime ideals.
PART -II

Dirichlet's Theorem on units, Dedekind's theorem for decomposition of rational prime in algebraic number fields, splitting of rational primes in cyclotomic fields.

References


MATH: 772S Topics in Number Theory –I

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective

The objective of this course is to familiarize the students with the theory of basic series and their applications in many Number Theory problems, particularly in Partition Theory.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-1

Basic hypergeometric series, q-binomial theorem, Heine's transformation, q-Gauss theorem, Restricted partitions, Gaussian polynomials, q-Saalschütz's theorem, Bailey's lemma (weak version), Rogers lemma, Rogers-Ramanujan identities, Schur's theorem, Gordon-Gollnitz identities, Generalization and various analogues of Rogers-Ramanujan identities.

PART-II

Bailey's lemma (strong version), Watson's q-analogue of Whipple's theorem and its applications in deriving Rogers-Ramanujan identities and Gordon-Gollnitz identities. 6-phi-5 identity and its applications to representations of numbers as sum of two squares, four squares and four triangular numbers. Frobenius partitions, coloured Frobenius partitions. Plane partitions.

Suggested Readings

Objective
The objective of this course is to introduce to the fundamentals of the study of fluid motion and to the analytical approach to the study of fluid mechanics problems.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Real fluids and ideal fluids, velocity of fluid at a point, streamlines, pathlines, streaklines, velocity potential, vorticity vector, local and particle rate of change, equation of continuity, irrotational and rotational motion, acceleration of fluid, conditions at rigid boundary.

Euler’s equation of motion, Bernoulli’s equation, their applications, Potential theorems, axially symmetric flows, impulsive motion, Kelvin’s Theorem of circulation, equation of vorticity.

PART-II

Some three dimensional flows: sources, sinks and doublets, images in rigid planes, images in solid sphere, Stoke’s stream function.

Two dimensional flows: complex velocity potential, Milne Thomson Circle Theorem and applications, Theorem of Blasius, vortex rows, Karman vortex street.

References
Math 774S: Algebraic Coding Theory-I

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
Coding theory is concerned with successfully transmitting data through a noisy channel and correcting errors in corrupted messages. The objectives is to introduce a first course of coding theory, the algebraic structure of linear codes, some special codes and several bounds in coding theory.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Error detecting and error correcting codes, maximum likelihood decoding, Hamming distance, Finite Fields, Linear Codes, Generator matrix and parity check matrix, Dual Codes, Syndrome Decoding, Weight Enumerator of a Code, Macwilliam equations, Macwilliam’s Identity, ISBN Codes, New Codes from old.

PART-II
Sphere covering bound, Sphere packing bound, Gilbert Varshamov bound, perfect codes, Hamming Codes, Golay codes, Simplex Codes, Singleton bound and MDS codes, Plotkin bound, Griesmer bound, Reed-Muller codes, Linear Programming bounds. The Johnson Upper bounds.

References
Math 775S-Non Commutative Ring Theory

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course is a prerequisite for the course Math 795S on Representation theory of finite groups, which is a subject of great importance.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Non-commutative rings and left/right Modules over them, Modules of finite length, Artinian and Noetherian Modules, Artinian and Noetherian Rings, Triangular Rings, Semi-simple Modules, Isotypical Components, Endomorphism Rings, Semi-simple Rings and Wedderburn- Artin’s Theorem.

PART-II


The Group Algebras and their augmentation ideals.

References

Objective
The objective of this course is to equip the students with knowledge of some advanced concepts related to partial differential equations and to understand some basic approach to mathematical oriented PDEs.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART – I

PART – II
Wave equation- Solution by spherical means, non-homogeneous problem, Energy methods. Non-Linear first order PDE: Complete Integrals, Envelopes, Characteristics, Hamilton-Jacobi equations, Hamilton’s ODE, Legendre transform, Hopf – Lax formula,

References:

Objective
This course introduces the tensors and mathematical aspects of the basic concepts of elastic body deformation. This is very helpful in understanding the mechanics of elastic bodies.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART – I

Tensors: Summation convention, coordinate transformation, Cartesian tensor of various orders, algebra of tensors, contraction, symmetric and skew-symmetric tensor. Kronecker delta, Alternating tensor, Gradient, Divergence, Curl in tensor notations, Gauss-divergence theorem, partial derivatives, contravariant and covariant tensors, metric tensor, physical components.

Strain Analysis: Affine transformation, infinitesimal affine transformation, geometrical interpretation of components of strain, strain quadric of Cauchy, strain-displacement relation.

PART – II

Strain Analysis (continued): Strain invariants, compatibility, principal direction and principal strain, homogeneous deformation.


References:
MATH 778S : Numerical Methods for Differential Equations-I

**Theory**
[4 hrs per week theory (including tutorials)]
Max. Marks:  80
[Final-60+Internal Assessment-20]
Time: 3hrs.

**Objective**
The aim of this course is to teach the basics of MATLAB package. At the end of the course, the students will be able to do programming in MATLAB and understand the basic concepts in Numerical Analysis of differential equations.

**Note:**
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each unit.
3. All questions carry equal marks.

**PART-I**
Basics of MATLAB: MATLAB as a calculator, Defining Variables, Display format, Saving the variables stored in memory, Predefined variable, Complex numbers, Vectors and Matrices.
Control Flow: If-end, If-else-end, Elseif, Switch-case, For loops: Single for loops, Nested for loops, Special cases of the for loop, While loops.
Functions: General Structure of function, Scope of variables, Passing variable, The Return statement, Nargin and nargout, Recursive functions.
Plotting: Basic two-dimensional plots, Line styles, Markers, Colors, Plot Color, Plotting grid, Axis command, Placing text on a plot, Modifying text with Tex commands.
Polynomial splines and Generalizations: Cubic splines, Definition of cubic and m splines, Derivation of B splines, Quintic spline interpolate, Splines and ordinary differential equations, Error analysis.
The method of collocation: Introduction, A simple special case, existence via matrix analysis, Green’s functions, Collocation existence via green’s functions, Error analysis via Green’s function, Collocation and partial differential equations, Orthogonal collocation, A connection between Collocation and Galerkin methods.

**PART-II**
Basic steps of finite element analysis: Model boundary value problem, Descretization of the domain, Derivation of element equation, Connectivity of elements, Imposition of boundary conditions, Solution of equations, Post processing of the solution, Radially symmetric problems.


Practical

[3 hrs per week, Max. Marks: 20]

Time: 3hrs

Writing programs in Matlab for the following problems and run them on PC.

1. Write a program in Matlab to solve a polynomial equation.
2. Write a program in Matlab to find $^nC_r$.
3. Write a program in Matlab to write a tridiagonal matrix.
4. Write a program in Matlab to solve the system of linear equations
   b) using Gauss Elimination
   c) using LU Decomposition.
5. Write a program in Matlab to find the characteristic roots and the characteristic functions
6. Let $\mathbf{U} = [U_1, U_2, \cdots, U_N]$ be a numerical solution of a problem and $\mathbf{u} = [u(x_1), u(x_2), \cdots, u(x_N)]$ be the exact solution of the problem at grid points. Write a program in Matlab to find the absolute error
   b) in maximum norm or infinity norm.
   c) in $L_2$ norm.
7. Write a Program in Matlab to find the numerical solution using Euler’s method (forward and backward numerical scheme) and compare it with the exact solutions.
   \[ y' = t/y \quad ; \quad 0 \leq t \leq 5 \]
   \[ y(0) = 1 \]
8. Write a program in Matlab to solve the following problem
   \[ h' + 0.002(52.1h + (10.3/(10.3+h))) - 1.17 (1+sin3t) = 0.0308, \quad h(0) = 5.0. \]
9. A simple model for the falling body with the initial conditions is
   \[ y'' = -1 + y'^2 \]
   \[ y(0) = 1, \quad y'(0) = 0. \]

Write a program in Matlab to find the value of $t$ for which $y(t) = 0$?
10. A model of flame propagation, when we light a match, the ball of flame grows rapidly until it reaches a critical size. Then it remains at that size because the amount of oxygen being consumed by the combustion in the interior of the ball balance the amount available through.

\[ y' = y^2 - y^3; \quad y(0) = p, \quad 0 \leq t \leq 2/p \]

Here, \( y(t) \) represents the radius of the ball. The \( y^2 \) and \( y^3 \) terms come from the surface area and volume. The critical parameter is the initial radius \( p \). Write a program in Matlab to find the numerical solution.

11. Consider the initial value

\[ x' = -(1 + t + t^2) - (2t - 1)x - x^2, \quad 0 \leq t \leq 3, \quad x(0) = -1/2. \]

The exact solution is given by

\[ x(t) = -t - 1/(e^t + 1). \]

Write a Program in Matlab to find the numerical solution and compare it with the exact solution.

12. A mass-spring system can be modeled via the following second-order ODE

\[ Y'' + cy' + w^2y = g(t), \quad y(0) = 1, \quad y'(0) = 0. \]

Write a program in Matlab to find the numerical solution for the particular set of conditions

\( c = 5, \quad w = 2 \) and \( g(t) = \sin(t) \)

13. Write a program in Matlab to evaluate shape functions for
   a) Three node element.
   b) Four node element.

14. Write a program in Matlab to find the numerical solution the reaction-diffusion problem defined on \((0,1)\) with the homogeneous boundary conditions using method of collocation.

15. Write a program in Matlab to find the numerical solution the convection-diffusion problem defined on \((0, 1)\) with the homogeneous boundary conditions using method of collocation.

16. Write a program in Matlab to find the numerical solution of the following problem

\[ y'' = -2, \quad 0 < x < 1 \]

\[ y(0) = 0, \quad y'(0) = 0 \]

using finite element method.

17. Write a program in Matlab to find the numerical solution of the Poisson equation defined on a square region with Dirichlet boundary condition using finite element method.
Practical shall be conducted by the department as per the following distribution of marks.

Writing program in Matlab and running it on PC=10 Marks

Practical record=5 Marks

Viva-Voice=5 Marks

References:

Semester IV

MATH 725S : Non-Linear Programming

[7 hrs per week (including tutorials)]
Max. Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
The objective of this course is to acquaint the students with the concepts of convex and non-
convex functions, their properties and various optimality results, techniques to solve nonlinear
optimization problems and their duals over convex and non-convex domains and to study game
theory.

Note: 1. The question paper will have eight questions. Candidates will attempt five
questions.
2. There will be four questions from each part and the students will be required
to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Nonlinear Programming: Convex functions, Concave functions, Definitions and basic
properties, subgradients of convex functions, Differentiable convex functions, Minima and
Maxima of convex function and concave functions. Generalizations of convex functions and their
basic properties.

Unconstrained problems, Necessary and sufficient optimality criteria of first and second
order, First order necessary and sufficient Fritz John conditions and Kuhn-Tucker conditions for
Constrained programming problems with inequality constraints, with inequality and equality
constraints. Kuhn-Tucker conditions and linear programming problems.

PART-II
Duality in Nonlinear Programming, Weak Duality Theorem, Wolfe’s Duality Theorem, Hanson-
Huard strict converse duality theorem, Dorn’s duality theorem, strict converse duality theorem,
Dorn’s Converse duality theorem, Unbounded dual theorem, theorem on no primal minimum.
Duality in Quadratic Programming.

Quadratic programming: Wolfe’s method, Beale’s method for Quadratic programming.
Linear fractional programming, method due to Charnes and Cooper. Nonlinear fractional
programming, Dinkelbach’s approach.

Game theory - Two-person, Zero-sum Games with mixed strategies, graphical solution, solution
by Linear Programming.

[Scope as in Chapter 17 of reference no.4, Chapter 3 & 4 of reference no.1, chapter 24, 26 and 28
of reference no2, Chapter 8 of reference no3, chapter 16 of reference no5]
References


MATH 770S: Functional Analysis

[7 hrs per week (including tutorials)]
Max. Marks: 100
[Final-80+ Internal Assessment-20]
Time: 3hrs.

Objective
This course is an introduction to Banach Spaces and Hilbert Spaces along with various operators/functionals so as to enable the students to study advanced topics in Functional Analysis like Spectral theory, Topological Vector Spaces, Banach Algebras etc., Baire’ Category theorem and its applications are also dealt with.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART- I

Baire Category theorem and its applications.
[Scope as in relevant topics of Chapter I from Ref.2]

Nomed Spaces, with examples of Function spaces \( L^p ([a,b]) \), \( C([a,b]) \) and \( C^1([a,b]) \), Sequence Spaces \( l^p, c, c_0, c_{00} \) Banach Spaces Hahn Banach theorem, open mapping theorem, closed graph theorem, Banach Steinhaus theorem (uniform boundedness principle), [Scope as in relevant topics from Chapter 2 & 3 of Ref.6.]

PART- II


Bounded Operators on Hilbert spaces: Bounded operators and adjoints; normal, unitary and self-adjoint operators, Spectrum and Numerical Range.
[Scope as in Ch.VI & VII (§25-27.7) of the book ‘Functional Analysis’ by B.V. Limaye, 1996.]
References:


Math 769S: Commutative Algebra II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective

Commutative Algebra is the study of commutative rings, their modules and ideals. This theory has been developed over the last 150 years not just as an area of algebra considered for its own sake, but as a tool in the study of two enormously important branches of mathematics: algebraic geometry and algebraic number theory. This course will give the student a background in commutative algebra which is used in both algebraic geometry and number theory.

Note:  1. The question paper will have eight questions. Candidates will attempt five questions.
       2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
       3. All questions carry equal marks.

PART-I

Rings and modules of fractions, local properties, extended and contracted ideals in rings of fraction, primary decompositions, integral dependence, the going up theorem, integrally closed domains, the going down theorem, valuation rings.

PART-II

Chain conditions, Noetherian and Artinian modules, Noetherian rings, primary decomposition I Noetherian rings.

References

3. Gopalakrishnan, N.S., Commutative Algebra, Oxonian Press (New Delhi) 1984

**MATH 781S: Computational Techniques –II**

**Theory**

[4 hrs per week (including tutorials)]
Max. Marks: 80
[Final-60+Internal Assessment-20]
Time: 3hrs.

**Objective**
The aim of this course is to learn the basics of computer program in Programming in ‘C’ at their own. For the purpose of learning programming skill, some Numerical methods which are extremely useful in scientific research are included. For practising the programmes of the numerical method, the course of practical has also been included in this paper. The contents of the curriculum has been developed keeping in view the UGC guidelines.

**Note:**
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.
4. Use of scientific calculator is allowed for numerical work.

**PART – I**

**Programming in C:** Historical development of C, Character set, constants, variables, C-key words, Instructions, Hierarchy of operations, Operators, Simple C programs, Control structures: The if, if-else, nested if-else, unconditional goto, switch structure, Logical and conditional operators, while, do-while and for loops, Break and continue statements, Arrays, Functions, recursion, Introduction to pointers.

**PART – II**

**Curve fitting:** Linear and non-linear curve fitting, curve fitting by sum of exponentials, fitting of exponential and trigonometric functions.

**Solution of Linear system of equations:** Matrix inversion, Gauss-elimination and Gauss-Jorden method, LU decomposition method, Gauss Seidal method.

**Solution of differential equations:** Taylor’s series, Euler’s, Modified Euler’s, Runge –Kutta methods and their extensions, Stability Analysis, Predictor –Corrector methods, Finite Difference and Shooting methods to solve BVP, FDM for Laplace and Heat equations.
Computational Techniques (Practical)-II

[3 hrs per week, Max. Marks: 20]*

Writing programs in C for the problems based on the method studied in theory paper and run them on PC.

Practical shall be conducted by the department as per the following distribution of marks:

Writing program in FORTRAN and running it on PC=10 Marks
Practical record=5 Marks
Viva-Voice=5 Marks

References:


*NOTE: There will be no internal assessment in the Practical examination.
Objective
This is a continuation of the course Math 771S which was introduction to algebraic number theory. In the present course some advanced topics of algebraic number theory are studied.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
Relative extensions, index of ramification, residual degree, Fundamental equality. Different and relative discriminant, Dedekind's theorem on ramified primes.

PART-II
Finiteness of class number, Determination of class numbers in special cases, Dirichlet’s class number formula and simple applications.

References
MATH: 792S: Topics in Number Theory –II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
Objective of this course is to illustrate further applications of basic series in the study of many combinatorial objects like Stirling numbers, Catalan Numbers, Ramanujan’s mock theta functions and Agarwal-Andrews coloured partitions.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
    2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
    3. All questions carry equal marks.

PART-I

Fibonacci numbers and their connection with partitions, Andrews' polynomial identity which implies Rogers-Ramanujan identities, r-Fibonacci sets and their applications in combinatorics, q-Fibonacci numbers. Recurrence relations, generating functions and other combinatorial properties of Stirling and q-Stirling numbers of the First and Second kinds. Bernoulli numbers and their connection with Reimann zeta function.

PART - II

Properties and applications of Catalan and q-Catalan numbers in combinatorics. 'Rank' and 'Crank' of a partition and their applications in providing combinatorial interpretations of the Ramanujan congruences. Mock theta functions and their combinatorial interpretations. n-Colour partitions, Conjugate and self-conjugate n-colour partitions, Restricted n-colour partitions, Rogers-Ramanujan type identities for n-colour partitions.

Suggested Readings

MATH-793S: Fluid Mechanics –II

[7 hrs per week (including tutorials)]
Max.Marks : 100
[Final-80+Internal Assessment-20]
Time: 3hrs.

Objective
This course is designed to make the students learn to develop mathematical models of fluid dynamical systems and use mathematical techniques to find solutions to these models.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Viscous Flows: Stress components, Stress and strain terror, coefficient of viscosity and Laminar flow, plane Poiseuille flows and Couette flow. Flow through tubes of uniform cross section in the form of circle, Ellipse, equilateral triangle, annulus, under constant pressure gradient.

Diffusion of vorticity. Energy dissipation due to viscosity, steady flow past a fixed sphere, dimensional analysis, Reynold numbers, Prandt’s boundary layer. Boundary layer equation in two dimensions, Karman integral equation.

PART-II

Elements of wave motion, waves in fluids, Surface gravity waves, standing waves, group velocity, energy of propagations, path of particles, waves at interface of two liquids.

References

Objective

Cyclic codes play a significant role in the theory of error correcting codes. They can be efficiently encoded using shift registers, which explains their preferred role in engineering. The objectives of this course is to teach the algebraic structure of cyclic codes over fields and rings, their properties and some special cyclic codes.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Review of finite fields, Factorization of $\mathbb{Z}_m$ over finite fields.

Subfield codes, Concatenated Codes, Trace Codes, Cyclic codes, decoding of cyclic codes, idempotents and multipliers, zeros of a cyclic code, decoding of cyclic codes, minimal cyclic codes, BCH codes.

PART-II

Duadic codes, Orthogonality of Duadic codes, Weights in Duadic codes, Quadratic Residue codes, Reed-Soloman codes, Generalized Reed Soloman codes, Cyclic codes over rings specially over $\mathbb{Z}_4$.

References

Math 795S-Representation Theory of Finite Groups

[7 hrs/per week (including Tutorials)]
[Max. Marks: 100]
(Final-80+Internal Assessment-20)
Time : 3hrs

Objective
The representation theory of finite groups solidifies one’s knowledge of group theory. It goes back to F. Klein who considered the possibility of representing a given abstract group by a group of linear transformations (matrices) preserving the group’s structure. Leading mathematicians such as G. Frobenius, I. Schur, W. Burnside and H. Maschke followed and developed the idea further. Essentially, it is designed to give an explicit answer to the question “What are the different ways (homomorphisms) a finite group G can occur as a group of invertible matrices over a particular field F?” The link between group representations over a field F and modules is obtained using the concept of a group ring F[G], thus an essential step is the systematic study and classification of group rings (the so-called semisimple algebras) which behave like products of matrix rings. Therefore, the story of the representation theory of a group is the theory of all F[G]-modules, viz modules over the group ring of G over F. The ultimate goal of this course is to teach students how to construct complex representations for popular groups as well as their character tables which serve as invariants for group rings. In addition to the applications to physical symmetry, the theory leads to significant applications to the structure theory of finite groups.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I
The Semisimplicity of Group Algebras, Maschke’s Theorem, Examples of Decompositions of Group Algebras, Simple Modules over K[G], Cyclic Modules over K[G], Representations, Characters of Representations, Group Characters, Orthogonality relations, Ordinary and Modular Representations, Examples of Representations.

PART-II
Some more examples of rational group representations, Integrity of Complex Characters, Burnside’s $p^aq^b$ -Theorem, Tensor product of representations, Induced representations, Restriction and induction, Frobenius reciprocity theorems, Conjugate representations, Clifford’s decomposition theorem, Mackey’s irreducibility criteria,

References
MATH 796S: Partial Differential Equations –II

Objective

The objective of this course is to enable the students to understand the concepts related to the solution of partial differential equations in arising in various fields.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART-I

Weak solutions, Uniqueness, Conservation Laws: Shocks, entropy condition, Lax-Oleinik formula, Weak solutions, Uniqueness, Riemann’s Problem, Long time behavior.


PART-II


References:

understand the dynamical behaviour of elastic bodies, some basic problems are included on wave propagation.

Note: 1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each part.
3. All questions carry equal marks.

PART – I

Equations of Elasticity: Strain energy density function, generalized Hooke’s law, Elastic constants and their significance, Homogeneous isotropic media, Displacement equation of motion for uniform media, uniqueness of solution, Beltrami-Michel compatibility equation.
Thermo-elasticity: Thermal stresses, Duhamel-Numann law, Dynamical equations of thermoelastic problems.

PART – II

Thermal stresses in spherical bodies.

Two dimensional propagation of elastic waves in isotropic solid, waves of dilatational and waves of distortion, Reflection of P, SV and SH waves from free surface of an elastic half-space, Reflection and refraction of these waves from solid-solid interface, Surface waves-Rayleigh and Love waves.

References:


MATH 798S : Numerical Methods for Differential Equations –II

Theory

[4 hrs per week theory (including tutorials)]
Max. Marks: 80
[Final-60+Internal Assessment-20]
Time: 3hrs.

Objective
At the end of the course, the students will be able to understand the basic concepts in the Numerical Analysis of Partial Differential Equations and use to MATLAB to compute the numerical solution of the Partial Differential Equations.

Note:
1. The question paper will have eight questions. Candidates will attempt five questions.
2. There will be four questions from each part and the students will be required to answer at least two questions from each unit.
3. All questions carry equal marks.
PART-I


Parabolic Initial-Boundary Value Problems:

Parabolic equations in one space variable: A model problem, series approximation, an explicit scheme for the model problem, truncation error, convergence of the explicit scheme, Fourier analysis of the error, an implicit method, the Thomas algorithm, the weighted average or $\theta$-method, a maximum principle and convergence for $\mu(1 - \theta) \leq \frac{1}{2}$, a three-time level scheme, more general linear problems, nonlinear problems.

Parabolic problems in two and three space variables: The explicit method in a rectilinear box, an ADI method in two dimensions, ADI and LOD methods in three dimensions, curved boundaries, application to general parabolic problems.

PART-II


Elliptic Boundary Value Problems: A model problem, Error analysis of the model problem, the general diffusion equation, boundary conditions on a curved boundary, error analysis using a maximum principle, asymptotic error estimates.

Practical

[3 hrs per week, Max. Marks: 20]

Time: 3hrs

Writing programs in Matlab for the following problems and run them on PC.

Consider the heat equation

$$u_t - \kappa u_{xx} = 0, \quad 0 < x < \pi, \quad 0 < t$$

with the initial data

$$u(x, 0) = \sin x$$

with the boundary data

$$u(0, t) = 0, \quad u(\pi, t) = 0.$$

Write program in Matlab to find the numerical solution of the initial-boundary value problem
2. Using Forward in time and central in space (FT-CS).
3. Using Backward in time and central in space (BT-CS).
5. Compare all the above schemes via plotting the numerical solution in Matlab.

Consider the initial-boundary value problem

\[ u_t + u_x = 0, \quad \text{on} \quad -2 < x < 3, \quad 0 < t \]

with the initial data

\[ u(x, 0) = \begin{cases} 1 - |x| & \text{if} \quad |x| \leq 1 \\ 0 & \text{if} \quad |x| > 1 \end{cases} \]

with the boundary data

\[ u(-2, t) = 0, \quad t \geq 0. \]

Write program in Matlab to find numerical solution of the problem

8. Using Lax-Friedrichs scheme.
10. Compare all the above schemes via plotting the numerical solution in Matlab.

Consider the Burger’s equation

\[ u_t + \left( \frac{u^2}{2} \right)_x = 0, \quad 0 \leq x \leq 1, \quad 0 \leq t \]

with the initial data

\[ u(x, 0) = \exp[-10(4x - 1)^2], \quad 0 \leq x \leq 1 \]

with the boundary data

\[ u(0, t) = 0, \quad t \geq 0. \]

11. Write a program to find the Numerical solution using Lax-Wendoff method.

Consider the Laplace equation

\[ u_{xx} + u_{yy} = 0, \quad (x, y) \in (0, 1) \times (0, 1) \]

with the boundary conditions

\[ u(x, 0) = 0, \quad u(x, 1) = x \]
\[ u(0, y) = 0, \quad u(1, y) = y. \]

12. Write a program in Matlab to find the numerical solution of the above problem.
13. Compare the numerical solution with exact solution.

14. Find the absolute and relative Error in maximum and $L^2$ norms.

References:

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