PANJAB UNIVERSITY CHANDIGARH- 160 014 (INDIA)

(Estted. under the Panjab University Act VII of 1947-enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABI

FOR

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

EXAMINATIONS 2015- 2016

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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 2015-2016.

Outlines of Tests

Semester I

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

(II)   **Environmental 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)   **Any one 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   :   Basic 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   :   Group Theory

        Paper II :   Math 402S   :   Analysis-I

        Paper III: Math 403S   :   Ordinary Differential Equations

Subsidiary Courses-2

    (1)   Statistics and Computational Methods

        Paper I   :   SC 201S   :   Applied Statistics-I

        Paper II   :   SCP 202S   :   Practicals of Applied Statistics-I

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

    (2)   Same Subsidiary as opted in Semester-I

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

Semester-IV

Major Papers-3

        Paper I :   Math 421S   :   Number Theory

        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-1   :   Math 501S   :   Rings and Modules

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   :   Advanced Linear Algebra

Paper-II   :   Math 522S   :   Lebesgue Integration and Fourier Series

Paper-III :   Math 523S   :   Partial Differential Equations

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

IMPORTANT NOTE:
        The Paper of Environment & Road Safety Education is a compulsory qualifying paper, which the students have to study in the B.A./B.Sc. 1st year (2nd Semester). If the student/s failed to qualify the paper during the 2nd Semester. he/she/they be allowed to appear/qualify the same in the 4th or 6th Semester/s.

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 (not 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 This questions 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:

   1.   *Business Communication,* Ed. Om. P. Juneja & Aarti Mujumdar, Hyderabad: Orient Blackswan, 2010.

   2.   *Textbook of Business Communication,* Anjali Kalkasr, R.B. Suryawanshi, Amlanjyoti Sengupta, Hyderabad: Orient Blackswan., 2010.

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 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   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.

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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 This questions 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:

1. *Business Communication,* Ed. Om. P. Juneja & Aarti Mujumdar, Hyderabad: Orient Blackswan, 2010.

2. *Textbook of Business Communication,* Anjali Kalkasr, R.B. Suryawanshi, Amlanjyoti Sengupta, Hyderabad: Orient Blackswan., 2010.

ENVIRONMENT AND ROAD SAFETY EDUCATION (SEMESTER – I)

UNIT I (ENVIRONMENT)

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

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 :**
    Population growth and family welfare programme, Human Health, HIV/AIDS, Human rights.

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.

Examination Pattern :

A qualifying paper of 50 marks comprising of fifty multiple choice questions (with one correct and three incorrect alternatives and no deducation for wrong answer or unattempted question), and of 1 hour duration.

The students have to obtain 33% marks to quality the paper. The marks are not added/included in the final mark sheet.

UNIT II (ROAD SAFETY)

1. Concept and Significance of Road Safety.
2. Role of Traffic Police in Road Safety.
3. Traffic Engineering – Concept & Significance.
4. Traffic Rules & Traffic Signs.
5. How to obtain Driving License.
6. Traffic Offences, Penalties and Procedures.
7. Common Driving mistakes.
8. Significance of First-aid in Road Safety.
9. Role of Civil Society in Road Safety.
10. Traffic Police-Public Relationship.

Note : Examination Pattern :

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

Suggested Readings

1. The Motor Vehicle Act, 1988 (2010), Universal Law Publishing Co. Pvt. Ltd., New Delhi.

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

Websites:

(a) www.chandigarhpolice.nic.in

(b) www.punjabpolice.gov.in

(c) www.haryanapolice.gov.in

(d) 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

$\in$-δ definition of the limit of a function. Basic properties of limits. Continuous functions and classification of discontinuities. Differentiability. Applications of Derivatives. Asymptotes. Test for concavity. Points of inflexion. Tracing of Curves.
(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

Applications of integrals. Areas between curves. Finding volumes by slicing. Volumes of solids of Revolution-Disks and Washers. Cylindrical Shells. Lengths of plane curves. Areas of surfaces of revolution.

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

Infinite Series

Limits of sequence of numbers. Theorems for calculating limits of sequences, Infinite Series. Bounded and Monotonic sequences, Cauchy's convergence criterion. Series of non-negative terms. Comparison tests. Cauchy's Integral test. Ratio tests. Alternating series. Absolute and conditional convergence. Lebnitz Theorem, Convergence of Taylor Series, Error Estimates. Applications of Power Series.
(Scope as in Chapters 8 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

Suggested Readings

1. George B. Thomas and Ross L. Finney: Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998.
2. Liefhold, Louis: Calculus and Analytic Geometry, 2nd Edition, New York, Harper & Row 1972.
3. Lipmen Bers: Calculus, IBH Mumbai 1974.
4. Thomas Calculus, 11th Edition, Pearson, 2008.

Paper-II

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 atleast 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, co-axial 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, Δ 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

1. P.K. Jain and Khalil Ahmed: A text book of Analytical Geometry of two dimensions, Wiley Eastern Ltd, 1994.
2. P.K. Jain and Khalil Ahmed: A text book of Analytical Geometry of three dimensions, Wiley Eastern Ltd, 1999.
3. Shanti Narayan and P.K Mittal: Analytical Solid Geometry, 17th Revised Edition, S. Chand and Co., New Delhi, 2006.

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 atleast two questions from each part.
3. All questions carry equal marks.

PART-I

Vector Analysis

Vectors in the plane. Cartesian Co-ordinates and vectors in spaces. Dot and cross products. Lines and planes in space, Cylinders and Quadric surfaces. Cylindrical and Spherical co-ordinates, Vector valued functions and space curves. Modelling Projectile Motion. Arc length and Unit Tangent vector, curvature, Torsion and the TNB Frame. Line and Surface integrals.
(Scope as in chapters 10, 11 and 14 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition)

PART-II

Multivariable Functions:

Functions of several variables. Limits and continuity. Partial derivatives. Differentiability. The chain rule, Directional derivatives, Gradient vectors and tangent planes. Extreme values and saddle points. Lagrange multipliers. Double integrals. Double integrals in Polar Form. Triple integrals in Rectangular co-ordinates. Triple integrals in Cylindrical and Spherical co-ordinates.
(Scope as in Chapters 12 and 13 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition).

Suggested Readings
1. George B. Thomas and Ross L. Finney: Calculus and Analytic Geometry, 9th Edition, Addison Wesley, 1998.
2. Liefhold, Louis: Calculus and Analytic Geometry, 2nd Edition, New York, Harper & Row 1972.
3. Lipmen Bers: Calculus, IBH Mumbai 1974.
4. Thomas' Calculus, 11th Edition, Pearson, 2008.

Math 322S: Basic Linear Algebra

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

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 atleast 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.

PART-II

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

Inner product, length, orthogonality, orthogonal projections, Cauchy-Schwartz inequality, Gram-Schmidt orthonormalization process, inner product spaces.

References

1. David C. Lay: Linear Algebra and its Applications, Addison Wesley, 2000.
2. K. Hoffman and R. Kunze: Linear Algebra, 2nd Edition, Prentice-Hall of India, 1989.
3. S. Lang: Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.
4. Schaum's Outlines: Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
5. S.H. Friedberg, A.J. Insel and L.E. Spence: Linear Algebra, Prentice Hall, 2003.
6. M. Artin: Algebra, Prentice Hall of India, 1994.
7. P. Lax, Linear Algebra, John Wiley & Sons, New York. Indian Ed. 1997
8. V.Krishnamurthy, V.P.Mainra & J.L.Arora : An Introduction to Linear Algebra, Affiliated East-West Press, 1976.

Semester III

Major Papers-3

Paper I - Math 401S: Group Theory

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

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

Introduction to groups, binary operation, semigroups, groups, the group of integers modulo n, dihedral group, symmetric group, Matrix groups, group of quaternion, subgroups, order of group elements, cyclic groups, subgroup generated by a subset, cosets, Lagrange's theorem, conjugacy, Normal subgroups, quotient groups, Homomorphisms, Isomorphism theorems.

PART-II

Detailed study of S_n, Simplicity of A_n, Group actions, class equation, properties of p-groups, Cayley's theorem, Cauchy's theorem, Sylow theorems, direct and semidirect products, groups of order p^2, pq, fundamental theorem of finitely generated abelian groups, groups of small order, series of subgroups, Schreier's refinement theorem and Jordan Holder theorem, solvable groups and nilpotent groups.

(Scope as in chapters 1-6 of Abstract Algebra by Dummit and Foote).

Suggested Books

1. Joseph A Gallian: Contemporary Abstract Algebra, 4th Edition, Narosa Publishing House, New Delhi 1998.
2. David S. Dummit and Richard M Foote: Abstract Algebra, John Wiley & Sons, 2004.
3. I.S.Luthar and I.B.S. Passi: Algebra Volume 1: Groups, Narosa Publishing House 1999.
4. I.N.Herstein: Topics in Algebra, 2nd edition, Vikas Publishing House, New Delhi 1976.
5. P.B.Bhattacharya, S.K.Jain and S.R.Nagpaul: Basic Abstract Algebra, 2nd Edition, Cambridge University Press 2002.
6. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, 7th Edition, Vikas Publishing House, New Delhi 1993.
7. M.Artin: Algebra, Prentice Hall of India, 1994.

Paper-II:Math 402S: :   Analysis -I

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 atleast 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 IR^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

1. Rudin, W.: Principles of Mathematical Analysis, 3rd Edition. McGraw Hill, 1976.
2   Apostol, Tom M.: Mathematical Analysis, second edition. Narosa Publishing House, Reprint 2002.
3.   Shirali, S. and H.L.Vasudeva: Metric Spaces, Springer, 2006.
4. Malik, S.C. and Savita Arora: Mathematical Analysis, New Age International Publishers, Reprint 2008.
5. Bartle, R.G. and D. R. Sherhert: Introduction to Real Analysis, third edition. John Wiley & Sons, Inc.,2000.

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

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.

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

PART- II

Second order Differential Equations: Linear equations with constant coefficients. Standard Methods for solution, Nonhomogeneous, linear with constant coefficients. Method of Variation of Parameter, Linear Independence, Linear dependence, Wronskian. Second order linear equation with variable coefficient.

Vector Calculus: Properties of gradient , divergence and curl , vector identities, Gauss divergence theorem, Green' theorem and Stokes theorem in vector form.

Tensors: Cartesian tensors and tensor operations.

Suggested Reading

1. W.E.Boyce and P.C.Diprima : Elementary Differential Equations and Boundary value problems, John Wiley, 1986.
2. Coddington, E.A. : An Introduction to Ordinary Differential Equations. Prenctice Hall (India),1961,

(Chapters I-V).

3. E.L.Ince : Theory of Ordinary Differential Equations. Dover ,1956.

4. E. D. Rainville: Elementary Differential Equations, Bedient Publisher Prentice Hall, 1997.

5. A text book of cartesian tensors: With an introduction to general tensors by Shanti Narayan , S. Chand , 1968, (Chapter 2)

6. Cartesian tensors By Harold Jeffrey, The University Press, Cambridge .

7. Textbook of Vector Calculus By Shanti Narayan, S. Chand.

Semester IV

Paper I : Math 421S :   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
1. G. H. Hardy and E.M. Wright : An Introduction to Theory of Numbers, *Oxford* University Press, 6th Edition , 2008.
2. I. Niven, H. S. Zuckerman and H. L. Montgomery : An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Edition, 2004.
3. H. Davenport: The Higher Arithmetic, Camb. Univ. Press, 7th Edition, 1999.
4. David M. Burton: Elementary Number Theory, Tata McGraw Hill, 6th Edition, 2007.

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 atleast 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
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 , ChapterVI(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] Sequences and series of functions, uniform convergence,

Books recommended
1. W. Rudin: Principles of Mathematical Analysis, 3rd Edition. McGraw Hill, 1976.
2. Tom M. Apostol: Mathematical Analysis, 2nd Edition. Narosa Publishing House, Reprint 2002.
3. S. Shirali and H. L. Vasudeva: Metric Spaces, Springer, 2006.
4. S.C. Malik and Savita Arora: Mathematical Analysis, New Age International Publishers, Reprint 2007.
5. R.G. Bartle and D. R. Sherbert: Introduction to Real Analysis, 3rd Edition, John Wiley & Sons, Inc. 2000.

Paper-III: Math 423S: Mechanics

[7 hrs per week (including tutorials)]

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

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 atleast two questions from each part.**
  3. **All questions carry equal marks.**

Part-I

Statics

System of two concurrent forces: Parallelogram law of forces, Resultant of two coplanar concurrent forces, Components of a force in given directions, Resolved parts of a force, Theorem of resolved parts of two concurrent forces.

System of two Parallel forces: Resultant of two parallel forces, Theorem of resolved parts of two parallel forces.

Moments and Couples: Moment of a force about a point and about a line; Couple, Moment of a couple, Varignon's theorem on moments of two coplanar forces.

Coplanar force system: Resultant of three concurrent coplanar forces, Algebraic method of finding the resultant of three coplanar concurrent forces, Theorem of resolved parts of three forces, Resultant of any number of coplanar concurrent forces, Algebraic method of finding the resultant of any number of coplanar concurrent forces, theorem on resolved parts.

Reduction of two coplanar forces to a single force or a single couple, Resultant of three coplanar forces to two, Reduction of any number of coplanar forces to a single force or a single couple.
Resultant and centre of any number of parallel forces.

Equilibrium of coplanar forces and couples: Triangle law of forces, converse of triangle law of forces, λ-μ Theorem, Lami's theorem, converse of lami's theorem, Equilibrium of a body resting on a smooth inclined plane.

Composition of couples: composition of any number of couples, equilibrium of couples, equivalence of couples.

Resultant of a force and a couple, resolution of a force into a force and a couple, reduction of a system of coplanar forces to a force and a couple.

Friction: Definition and nature of friction, coefficient of friction, angle of friction, cone of friction, laws of friction, equilibrium of a particle on a rough plane.

Part-II

Dynamics

Motion of a particle in a straight line: Motion of a particle with constant acceleration, motion of a body let fall free from rest, motion of a body projected vertically upwards.

Newton's Laws of Motion: Newton's Laws of Motion, Motion along a smooth inclined plane, constrained motion along a smooth inclined plane.

Variable acceleration: Simple harmonic motion, Projectiles.

Linear momentum, angular momentum, conservation of angular momentum, impulsive forces, principle of impulse and momentum

Work, power and energy: Work, power, conservative fields and the potential energy, work done against gravity, potential energy of a gravitational field.

Suggested Reading

1. Chorlton, F.: Text Book of Dynamics, CBS New Delhi (1985).
2. A Text Book of Mechanics for TDC I, TDC II Publication Bureau, Panjab University, Chandigarh.
3. S.L. Loney: The Elements of Statics and Dynamics , Cambridge University Press, 1897.

SEMESTER-V

Paper I : Math 501S : Rings and Modules

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

Objective:
This course 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.

PART-I (Rings)

Rings, Integral domains, Division rings, Fields, Subrings and Ideals, Algebra of ideals, Quotient rings, Prime ideals and maximal ideals, Homomorphism, Fundamental theorem of homomorphism, the first and the second theorems of isomorphism, Field of quotients and embedding theorems. Factorization and Divisibility in integral domains, Unique Factorization Domains (UFDs), Principal Ideal Domains (PIDs), Euclidean domains and relationships between them, Primitive Polynomials and Gauss Lemma, Eisenstein's irreducibility criterion, Factorization of polynomials in one variable over a field, Unique Factorization in *R[X], R a UFD* (Scope as in Chapters 7-9 of Abstract Algebra by Dummit & Foote).

PART-II (Modules)

Modules, definition and examples, Submodules, Quotient modules, Free modules, Comparison with vector spaces, Homomorphisms, Simple and Semisimple Modules, Structure of finitely generated modules over a PID. the rational canonical form, the Jordan canonical form. (Scope as in Chapter 10 (10.1-10.3) and Chapter 12 of Abstract Algebra by Dummit & Foote).

Suggested Books

1. David S. Dummit and Richard M Foote: Abstract Algebra, John Wiley & Sons, 2004.
2. I.S.Luthar and I.B.S. Passi: Algebra Volume II & III: Rings and Modules, Narosa Publishing House 1999.
3. Surjeet Singh and Qazi Zameeruddin: Modern Algebra, 7th Edition, Vikas Publishing House, New Delhi 1993.
4. I.N. Herstein: Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976.
5. N.S.Gopalakrishnan : University Algebra, 2nd Edition, Wiley Eastern Limited, 1988.
6. B. Hartley and T.O. Hawkes: Rings and Modules, Chapman and Hall.
7. J.A. Gallian: Contemporary Abstract Algebra,4th Edition, Narosa Publishing Company, New Delhi 1998.
8. P.B.Bhattacharya, S.K.Jain and S.R.Nagpaul: Basic Abstract, Algebra, Cambridge University Press 1995.

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

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's Theorem for function of n-variables.

Inverse function theorem. Implicit function theorem. Maxima and Minima at interior points. Criteria for local maxima and local minima. The method of Lagrange multipliers.
[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 IR^n , the Riemann integral of a bounded function defined on a compact interval in IR^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.
[Scope as in the book 'A Course on Mathematical Analysis' by Shanti Narayan, Twelfth Edition, Chapter 9 and 15]

Suggested Reading
1. T. M. Apostol: Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.
2. E.C. Titchmarsh: A Theory of Functions, Indian Edition, Published by Oxford University Press, Delhi, 1976.
3. W. Rudin : Principles of Mathematical Analysis, 3rd Edition, McGraw Hill, 1976.
4. T.J.I'A Bromwich : An introduction to theory of infinite series (Appendix II), 1926.
5. Shanti Narayan : A course of Mathematical Analysis, 12th Edition, 2000.

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

Objective

The objective of this course is to introduce the special function 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 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: Regular singular points, ordinary points, series solution. Method of Frobenius , Applications, Legendre's, Hermite's and Bessel's equation.

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, Reccurence 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.

Review of Fourier series, Fourier integrals, Applications of Fourier series, Fourier transforms, [Scope as in the book 'Advanced Engineering Mathematics' by R. K. Jain and S. R. K. Iyengar, Chapter 7, 8, 9]

Books recommended
    1.   R. K. Jain and S.R.K.Iyengar : Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House, 2004.

2.   E. D. Rainville: Special Functions, NY Macmillan, 1960.

3.   Coddington, E.A. : An Introduction to Ordinary Differential Equations. Prenctice Hall (India), 1961.

PAPER IV: MATH 504S: NUMBER THEORY-I

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

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

1.   G. H. Hardy and E. M. Wright: An Introduction to Theory of Numbers, *Oxford* University Press, 6th Ed , 2008.
2.   I. Niven, H. S. Zuckerman and H. L. Montgomery : An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Ed., 2004.
3.   H. Davenport : The Higher Arithmetic, Camb. Univ. Press, 7th edition, 1999.
4.   G. E. Andrews: Number Theory, Dover Books, 1995.
5.   T. M. Apostol : Introduction to Analytic Number Theory, Narosa Publishing House,

New Delhi, 1990.

6. David M. Burton – Elementary Number Theory, Tata McGraw Hill, 6th Edition, 2007

PAPER V: Math 505S: Discrete Mathematics and Graph Theory

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, Eulerian and Hamiltonian trails and cycles. Bipartite multigraphs, Trees, Spaning Trees, Algorithams 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 R.A. Brualdi , Chapters 1-3,5-8,11 (except § 11.6), 12 .1, 13.1,13.2)

Suggested Readings

1. R.A. Brualdi: Introductory Combinatorics, 5th Edition, Pearson, 2010.
2. J. L. Mott, Kandel and T. P. Baker: Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall, 1986.

Semester-VI

Paper I - Math 521S: Advanced Linear Algebra

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

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-1

Invariant subspaces, simultaneous triangulation and diagonalization, direct sum decomposition, Primary decomposition Theorem, Cyclic subspaces and annihilators, Cyclic decomposition and rational form, The Jordan canonical form, computation of invariant factors, semisimple operators.

PART-II

Inner product spaces, Linear functional and adjoints, Unitary operators, Normal operators, Forms on inner product spaces, positive forms, spectral theory and properties of normal operators, Bilinear forms, Symmetric and skew symmetric bilinear forms, Groups preserving bilinear forms.

(Scope as in chapters 6-10 of Linear Algebra by Hoffman & Kunze).

References

1. K. Hoffman and R. Kanze:, Linear Algebra, 2nd ed, Prentice-Hall of India, 1989.
2. S.H. Friedberg, A.J. Insel: L.E. Spence, Linear Algebra, Prentice Hall, 2003.
3. V. Sahai, V. Bist: Linear Algebra, Taylor and Francis, 2002.
4. J. Gilbert and L. Gilbert: Linear Algebra and Matrix Theory, Academic Press, 1995.
5. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: First Course in Linear Algebra; Wiley Eastern Ltd.
6. S. Lang: Linear Algebra, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.

Paper II Math-522S: Lebesgue Integration and Fourier Series

<div align="right">

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

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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-1

Lebesgue outer measure, measurable sets and Lebesgue measure, Construction of a non-measurable set, measurable functions, Littlewood three principles.
[Scope as in Chapter 2 of the book 'Real Analysis', 3rd Edition, 2000 by H. L. Royden]

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.

[Scope as in §10.22, §11.1-§11.5, §11.7-§11.12 of the book 'Mathematical Analysis' 2nd Edition, by T. M. Apostol]

Suggested Reading:
   1. H. L. Royden: Real Analysis, 3rd Edition, Prentice Hall of India, 2007.
   2. T. M. Apostol: Mathematical Analysis, 2nd Edition, Narosa Publishing House, Reprint 2002.
   3. E.C. Titchmarsh :   A Theory of Functions, Indian Edition, Published By Oxford University Press, Delhi, 1976.

Paper III   Math-523S: Partial Differential Equations

<div align="right">

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

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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.

<div align="center">

PART- I

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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.

Partial differential equations of the first order: Partial differential equations, solution of Partial differential equations in three variables. Partial differential equations of the first order. Cauchy's Problem for first order equations, Linear Partial differential equations of the first order, Integral surfaces passing through a given curve, surfaces orthogonal to a given system of surfaces.

<div align="center">

PART II

</div>

Partial differential equations of the first order: Nonlinear Partial differential equations of the first order, compatible system of first order equations, Charpit method, Jacobi Method, Cauchy's method of characteristics.

Partial differential equations of the second order and their classification into hyperbolic, elliptic and parabolic types, canonical forms. Linear partial differential equations with constant coefficients. Dirichlet and Neumann boundary conditions. Laplace, Diffusion and Wave equations and their solutions in Cartesian, Spherical polar and cylindrical polar coordinates by Separation of Variables.

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

Books recommended
1. R. K. Jain and S.R.K.Iyengar: Advanced Engineering Mathematics, 2nd Edition, Narosa Publishing House, 2nd Edition, 2003.
2. I. N. Sneddon: Elements of Partial Differential Equations, Dover Publications, Inc. Mineola, NY, 2006.

Paper IV: Math 524S : Number Theory- II

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 $a_1 x_1^{r_1} + a_2 x_2^{r_2} + ... + a_n x_n^{r_n} \equiv 0 \pmod{p}$, 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

1. G. H. Hardy and E. M. Wright: An Introduction to Theory of Numbers, *Oxford* University Press, 6th Ed , 2008.
2. I. Niven, H. S. Zuckerman and H. L. Montgomery: An Introduction to the Theory of Numbers, John Wiley and Sons, (Asia) 5th Ed., 2004.
3. G. E. Andrews: Number Theory, Dover Books, 1995.
4. T. M. Apostol – Introduction to Analytic Number Theory, Narosa Publishing House, New Delhi (1990)
5. Z. I. Borevich & I. R. Schafarevich: Number Theory Academic Press, 1966.

Paper-V: Math 525S: Numerical Analysis

Objective

The objective of the course is to expose the students with different aspects of basic numerical methods to solve polynomial equations, 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-I

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

Non-Linear Equations: Bisection, Regula-Falsi, Secant, Newton-Raphson, Muller, Chebshev and General Iteration Methods and their convergence, Aitken Method for acceleration of the Convergence, Methods for multiple roots, Newton-Raphson and General iteration Methods for System of Non-Linear Equations, Methods for Complex roots and Methods for finding roots of Polynomial Equations. [Ref.1 Chap 2]

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: Gerschgirun Theorem, Jacobi, Givens methods Householder's method for Symmetric matrices, Ruthishauser, Power and Inverse Power method. [Ref.1, Chap 3]

PART-II

Interpolation and Approximation of Functions:

Lagrange's interpolation, Newton Interpolation, Finite Difference Operators, Piecewise and Spline Interpolation, Interpolating Polynomials using Finite Differences and Hermite Interpolation. Least square approximation, Uniform approximation, Rational approximation [Ref.1 Chap 4]

Numerical Integration: Numerical Differentiation, Error in Numerical Differentiation, Cubic Spline method, Maximum and Minimum values of a tabulated function, Numerical Integration: Trapezoidal Rule, Simpson's 1/3-Rule, Simpson's 3/8-Rule, Boole's and Weddle's Rule, Integration using Cubic Splines, Romberg Integration, Newton Cotes formulae, Adaptive

Quadrature, Gaussian Integration, Euler-Maclaurin Sum Formula, Numerical Integration of Singular and Fourier Integrals, Numerical Doule 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

1. MK Jain, SRK lyenger and RK Jain: Numerical Methods for Scientific and Engineering Computations, 5th Edition, New Age Intenational (P) Limited, Publishers, New Delhi, 2007.

2. Kendall E Atkinson: An introduction to Numerical Analysis, 2nd Edition John Wiley & Sons, Printed in India by Replika Pvt. Ltd., 1989.

3. S.S.Sastry: Introductory Methods of Numerical Analysis, 3rd Edition (2000), Prentice Hall of India Pvt. Ltd., New Delhi.

4. FB Hilderbrand : Introduction to Numerical Analysis, 2nd Edition, Dover Publication Inc, New York, 1987.

Mathematics Subsidiary Courses for students of other Science Departments [SESSION 2015-2016]

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:
1. Mathematics, A Text book for Class XI and XII, NCERT,2003 New Delhi.
2. 'Calculus' by Thomas & Finney, 9ᵗʰ Edition, Pearson Education, 2004.

(For Students with background in Mathematics)

MATH 115S: Advanced Calculus and Geometry

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

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 candidates will be required to attempt 6 questions selecting 3 questions from each part.

Advanced Calculus and Geometry

Multivariable Functions and partial derivatives: Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradiant vectors and tangent planes (Chapters 11 Secs. 11.1, 11.3, Chapter 12.1-12.3 and 12.7 of Calculus and Analytic Geometry by Thomas and Finney, Ninth Edition).

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.

[Scope as in Sections 13.1 to 13.4, 13.6, 13.7 of Chapter 13 in the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9th Edition.]

Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only).
[Scope as in Sections 14.1, 14.3, 14.4, 14.5, 14.7 of Chapter 14 of the book 'Calculus and Analytic Geometry' by G. B. Thomas and R. L. Finney, 9th Edition.]

Plane Geometry : Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation $S=Ax^2+Bxy+Cy^2+Dx+Ey+f=O$ into simpler forms by transformation of coordinate axes(without proof). Identification of curves represented by S=0. Invariance of discriminant Δ 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

1. Thomas and Finney: Calculus and Analytic Geometry, Ninth Edition, Addison WEslet, 1995.
2. Shanti Narayan: Analytic Geometry.
3. J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra : New Pattern Vector   Algebra and Geometry, International Publishers, New Edition(2004).

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

Continuity and Differentiability: Introduction. Limits. Continuity. Differentiability. Exponential and Logrithmic Differentiation. Derivative of a function in parameter Second order derivative . Mean Value Theorem [Scope as in Chapter 13 of a text book of Mathematics of XI & Chapter 5 of a text book- Mathematics for class XII Part- I NCERT].

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.]

Indeterminate forms, L'Hopital's Rule. Taylor and Maclaurin series(without proofs). [Scope as in Section 6.6 of Chapter 6 and Section 8.9 & 8.10 of Chapter 8 of a book 'Calculus' by Thomas & Finney, 9th Edition.]

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]

Differential Equations : Introduction & basic concepts. General and particular solutions of a differential Equation. Formation of differential equation.Methods of solving First order, First degree Differential equations [Scope as in Ch 9 of a text book-Mathematics for class XII Part II]

Suggested Readings
Scope as in the relevant chapters of the books:
1. Mathematics, A Text book for Class XI and XII (Parts I & II), NCERT 2003, New Delhi.
2. 'Calculus' by Thomas & Finney, 9th Edition, Pearson Education, 2004.

(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

Vector spaces over R and C, subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and Determinantal rank of a matrix. Elementary row and column operations. Elemetary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only). Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.

[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

Cayley-Hamilton Theorem. Characteristic roots and Characteristic vectors of a square matrix. Nature of roots of different type of matrices, Minimal polynomial of a matrix.

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

1. V. Krishnamurty, V.P. Mainra and J. L. Arora, Introduction to Linear Algebra, East-West Press Pvt. Ltd. 1976.

2. Shanti Narayan and P. K. Mittal , A textbook of Matrices, S. Chand & Co., 2010.

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 atleast 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 Determinental 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.]

System of linear equations, consistency and inconsistency. Homogeneous and non-homogeneous equations. Gauss method of solving a system of equations.
[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

Characteristic equation of a square matrix. Characteristic roots and characteristic vectors. Nature of Characteristics roots of special matrices. Cayley-Hamilton Theorem (statement only).
[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

1.   Shanti Narayan & P. K. Mittal, A Text Book of Matrices, S. Chand & Co. Ltd., New Delhi, Reprint 2002.

(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

Exact First Order Differential Equations, Linear second order equations. Homogeneous equation with constant coefficients, Characteristic equation and their roots. Non-homogeneous equations of second order, Particular integrals, method of variation of parameters.

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

Fourier Series; Periodic functions. Fourier series and Fourier coefficients. Functions having arbitrary period. Sine and Cosine series. Half-range expansions. Exponential and complex form of Fourier series. Differentiation and integration of Fourier series. Fourier integrals.

Formation of first and second order of partial differential equations and their classification, solution of first order equation, Lagrange's equation. Solution of Laplace, diffusion and wave equations by method of separation of variables. D'Alembert's solution of wave equation.

[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

1. R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2003.
2. Sokolnikoff and Redheffer : Mathematics for Physics and Engineering, McGraw-Hill, 2nd Edition, 1966..
3. Erwin Kreyszig : Advanced Engineering Mathematics (Wiley Eastern Limited), 8th edition, 2006.
4. R. V. Churchill & J. W. Brown : Complex Variables and Application, 4th Edition, McGraw Hill, NY, 1984.

Semester-IV
(For students without background in Mathematics)
MATH 225S : Vector Analysis, Differential Equations and Transforms

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

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 atleast two questions from each part.
   3. All questions carry equal marks.

PART-I

Vector valued functions. Limit and continuity of vector functions., Differentiation of vector functions., Arc length., Line, Surface and Volume integrals. The gradient, divergence and curl. The del operator. Green's, Gauss' and Stokes' theorems (statements only). Applications to physical problems. [Scope as in Chapters 9-11 of 'A Text Book of Vector Analysis' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Revised Edition 2003.]

Differential Equations and their solutions, Equations with variables separable, Homogeneous equations, First order linear equations.

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 Laplac equation.
[Scope as in Sections 4.5-4.7, 5.1, 5.2, 5.3.1, 5.3.2, 5.4.1, 5.5, 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
1. H. F. Davis & A. D. Snider, Introduction to Vector Analysis, Allyn and Bacon, Inc., Boston, USA, 1995.
2. Shanti Narayan & P. K. Mittal, A Text Book of Vector Analysis, S. Chand & Co.Ltd., New Delh, 2003.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Ltd., N. Delhi.Revised Edition 2003.
4. R.K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics(Narosa Publishing House), 2nd edition,2005.

(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 atleast two questions from each part.**
3.   **All questions carry equal marks.**

PART- I: Laplace Transforms

Laplace Transforms : definition, elementary transforms. Transforms of derivatives and integrals. Transforms of periodic functions. Convolution theorem. Inverse Laplace transforms. Application to ordinary differential equations.

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 (statem*ent only). Evaluation of definite integrals using contour integration.*

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

Suggested Readings

1   R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2nd edition, 2004.
2   Sokolnikoff and Redheffer : Mathematics for Physics and Engineering 2nd Edition, 1996.
3   Erwin Kreyszig: Advanced Engineering Mathematic (Wiley Eastern Limited), 10th Edition, 2011.
4   R. V. Churchill & J. W. Brown : Complex Variables and Application, 4th Edition,1995.

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 2015-2016

(ECONOMICS SUBSIDARY)

FIRST YEAR – MICROECONOMICS
<u>SEMESTER – I</u>

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)

<u>UNIT – I</u>

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.

<u>UNIT - II</u>

Demand analysis. Consumer equilibrium and analysis of consumer demand for a product:

Marshallian utility and indifference curve analysis. Market demand and demand elasticities.

<u>UNIT – III</u>

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.

<u>UNIT – IV</u>

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.

P W Bell and M A Todaro (1969)   :   Economic Theory: An Integrated Text.

J M Joshi and Rajendra Joshi (1994) :   Microeconomic Theory – An Analytical
                                            Approach, Wishwa Prakashan.

R A Bilas (1967)   :   Microeconomic Theory – A Graphic
                                            Analysis.

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 questions 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.

P W Bell and M A Todaro (1969)   :   Economic Theory: An Integrated Text.

J M Joshi and Rajendra Joshi (1994) :   Microeconomic Theory – An Analytical

                                                        Approach, Wishwa Prakashan.

R A Bilas (1967)   :   Microeconomic Theory – A Graphic

                                                        Analysis.

SECOND YEAR – MACROECONOMICS
SEMESTER – III

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

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

Rowan, D C (1974)   :   Output, Inflation and Growth, 2nd Edition
Shapiro, Edward (1998)   :   Macro Economics, 5th Edition,
                                            Galotia Publications
Samuelson and Nordhas (1998)   :   Economics, 16th Edition, McGraw-Hill
Dornbusch and Fisher (1997)   :   Macroeconomics, McGraw-Hill.

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

Stablization 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, 2nd Edition
Shapiro, Edward (1998)	:	Macro Economics, 5th Edition, Galotia Publications
Samuelson and Nordhas (1998)	:	Economics, 16th Edition, McGraw-Hill
Dornbusch and Fisher (1997)	:	Macroeconomics, McGraw-Hill.

Outlines of tests, syllabi and courses of reading in the subject of Philosophy (Subsidiary)for the students of B. Sc. (Honours School) in Mathematics 1ˢᵗ to 4ᵗʰ Semesters for the examinations of 2015-16

1ˢᵗ Year B. Sc. (Honours School) in Mathematics

ELEMENTARY PHILOSOPHY

SEMESTER I

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

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.   Branches of Philosophy.
     c.   Relation of Philosophy to Science and Religion.

UNIT II

2.   a.   Meaning of Knowledge.
     b.   Sources of Knowledge.
     c.   Theories of Truth.

UNIT III

3.   a.   Doctrine of Karma and the problem of Freedom with special reference to Bhagavad-Gita.
     b.   Introduction to Ashtanga yoga (Patanjal Yoga Sutra).

UNIT IV

4.   a.   What is Idealism.
       b.   Different kinds of Idealism.
       c.   Idealism verses Realism.

SEMESTER II

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

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.
       c.   Ontological Proof for the Existence of God.

UNIT III

3.   a.   Nature of Aesthetics.

      b.   Theories of Art.

      c.   Aesthetic Experience.

UNIT IV

4.   a   Philosophy of Culture.

      b.   Meaning and origin of Culture.

      c.   What are Values (Ethical &Moral).

Essential Readings

1.   Chandogya Upanishads.   E BOOK by Swami Krishnanda Bhagavad-Gita.

2.   H Titus -   Living Issues in Philosophy Published by American Book Company. New York 1959.

3.   G.C. Pande   Meaning and Process of Culture. Published by Shivlal Aggarwal & Co. Agra: 1952.

Suggested Readings

1.   B. Russell Problems of Philosophy. (Oxford University Press. Paperback. London: 1959.
2.   A.C. Ewings Fundamental Questions of Philosophy. Routledge & Kegan Paul. London: 1951.
3.   M.Hiryanna Outlines of Indian Philosophy Published by M/s Kayalaya   Publishers, Delhi 1993.

2nd Year B. Sc. (Honours School) in Mathematics

SUBSIDIARY PHILOSOPHY

(LOGIC)

SEMESTER III

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

AIMS AND 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 PAPER SETTERS AND THE CANDIDATES:

i)   The theory question paper will be of 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 contacting 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 answers type questions i.e. 2 marks of each. It shall carry 20 marks and shall   be compulsory questions. Rest of the paper contains 4 units. Each unit shall have   2 questions and the candidate shall be given internal choice i.e. the candidate shall   attempt one question from each unit – 4 in all.

Unit –I

An introduction to the subject matter and scope of Logic.

Definition of Proposition and its classification.

Inference and its types - (i) Immediate Inference – Conversion, Obversion, Contraposition, Inversion and inference drawn on the basis of the Square of Proposition. (ii) Mediate Inference or Syllogism – Its Axioms, Figures, Moods and Fallacies.

Unit II

Classification of Proposition according to (i) structure –Simple and Compound and according to (ii) Truth Value - Tautology, Contradiction and Contingent.

Symbolization of Propositions, Proposition and Propositional Form.

Truth Functions.

Argument and Argument Form.

Unit III

Introduction to the Natural Deductive System - Rules of Inference and Replacement, Methods of proof of validity of arguments (Formal, Conditional and Indirect Proofs) and Method of proof of Invalidity of argument (Shorter Truth Table method).

Unit IV

An introduction to Inductive reasoning, Formal grounds of Induction (Law of Causation and Law of Uniformity of Nature), Inductive generalization, Paradox of Induction.

Inductive reasoning as Probable reasoning, Nature and theories about Probability, Calculus of Probability.

Essential Readings

1. Irving M. Copi: Introduction to Logic.
2. Irving M. Copi: Symbolic Logic (Macmillan Collier, New York) 5th Edition.
3. Cohen & Nagel: Introduction Logic & Scientific Method (Allied Publishers).

Further Readings
1. B. Russell: Principles of Mathematics (Allen & Unwin London).
2. Jean Necod: Foundation of Geometry and Induction (Kegan Paul).

SEMESTER IV

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

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AIMS AND 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.

INSTRUCTION FOR PAPER SETTERS AND THE CANDIDATES:

i) The theory question paper will be of 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 contacting 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 answers type questions i.e. 2 marks of each. It shall carry 20 marks and shall be compulsory questions. Rest of the paper contains 4 units. Each unit shall have 2 questions and the candidate shall be given internal choice i.e. the candidate shall attempt one question from each unit – 4 in all.

Unit I

Introduction to the Theory of Quantification and Symbolization of singly and multiply general propositions.

Construction of Proofs of Validity and Invalidity of Arguments involving general propositions.

Unit II

Introduction to the Logic of Relation - Symbolization of propositions. containing relational predicates, Formal properties of relation (Symmetry, Transitivity and Reflexivity).

Boolean Normal Forms, Identification of forms of statements as – Tautology, Contradiction and Contingent.

Unit III

An introduction to the Formal Deductive System: Logical and Non-logical Signs, Definitions, Axioms, Rules and Theorems, Consistency and Completeness as important properties of Deductive System.

Development of 1st Order Propositional Calculus.

Unit IV

An introduction to Scientific Method as a distinctive method of rational enquiry.

Steps of Scientific Method - occasion of enquiry, formation of Hypothesis and formal condition that a scientific hypothesis must satisfy, Test of hypothesis, role of crucial experiment.

Nature of scientific theories.

Nature of scientific explanation.

A critical evaluation of Mill's Methods of Experimental Enquiry.

Essential Readings

1. Irving M. Copi: Introduction to Logic.
2. Irving M. Copi: Symbolic Logic (Macmillan Collier, New York) 5th Edition.
3. Cohen & Nagel: Introduction Logic & Scientific Method (Allied Publishers).

Further Readings
1. B. Russell: Principles of Mathematics (Allen & Unwin London).
2. Jean Necod: Foundation of Geometry and Induction (Kegan Paul).

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