DETAILS OF COURSES

FIRST DEGREE PROGRAMMES UNDER CBCS

B.Sc MATHEMATICS

(PROGRAMME CODE: 220)

SEMESTER I

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Language course 1			4
Language course 2			3
Foundation course 1			2
Core course 1	MM 1141	Methods of mathematics	4
Complementary course 1	ST 1131.1	Descriptive statistics	2
Complementary course2	CS 1131.3	Introduction to IT	2

SEMESTER II

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Language course 3			4
Language course 4			3
Language course 5			3
Foundation course 2	MM 1221	Foundation of mathematics	3
Complementary course 1	ST 1231.1	Probability and Random variables	2
Complementary course 2	CS 1231.3	Programming in C	2

SEMESTER III

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Language course 6			4
Language course 7			4
Core course 2	MM 1341	Elementary Number Theory and Calculus I	4
Complementary course 1	ST 1331.1	Statistical Distribution	3
Complementary course2	CS 1331.3	Computer graphics	3

SEMESTER IV

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Language course 8			4
Language course 9			4
Core course 3	MM 1441	Elementary Number Theory and Calculus II	4
Complementary course 1	ST 1431.1	Statistical Inference	3
Practical	ST 1432.1	Practical using Excel	4
Complementary course2	CS 1431.3	Data structures and algorithms	3
Practical	CS 1432.3	Practical	4

SEMESTER V

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Core course 4	MM 1541	Real Analysis –I	4
Core course 5	MM 1542	Complex Analysis- I	3
Core course 6	MM 1543	Abstract Algebra-I-Group Theory	4
Core course 7	MM 1544	Differential Equations	3
Core course 8	MM 1545	Mathematics Software-LATEX And SageMath	3
Open course	MM 1551.1	Operation Research	2
Project		project	

SEMESTER VI

COURSES	COURSE CODE	COURSES TITLE	CREDITS
Core course 4	MM 1641	Real Analysis –II	4
Core course 5	MM 1642	Complex Analysis- II	3
Core course 6	MM 1643	Abstract Algebra-Ring Theory	3
Core course 7	MM 1644	Linear Algebra	4
Core course 8	MM 1645	Integral Transforms	3
Open course	MM 1651	Elective Course- Graph Theory	2
Project	MM 1646	project	4

SEMESTER-1

Core Course 1: MM 1141 Methods of Mathematics

Instructional hours per week: 4 No of credits: 4

Aim and objectives

In this paper, we quickly review the fundamental methods of solving problems
The limiting method, finding the rate of changes through differentiation method, finding the area under a curve through the integration method.

Module I - Methods of Differential Calculus (36 Hours)

In the beginning of this module, the basic concepts of calculus like limit of functions especially infinite limits and limits at infinity, continuity of functions, basic differentiation, derivatives of standard functions, implicit differentiation etc. should be reviewed with Examples.

The above topics which can be found in chapter 2 of text [1] below are not to be included in the end semester examination.

A maximum of 5 hours should be devoted for the review of the above topics.
After this quick review, the main topics to discuss in this module are the following:

- Differentiating equations to relate rates, how derivatives can be used to approximate non-linear functions by linear functions, error in local linear approximation, differentials; Increasing and decreasing functions and their analysis, concavity of functions, points of inflections of a function and applications, finding relative maxima and minima of functions and graphing them, critical points, first and second derivative tests, multiplicity of roots and its geometrical interpretation, rational functions and their asymptotes, tangents and cusps on graphs;

- Absolute maximum and minimum, their behavior on various types of intervals, applications of extrema problems in finite and infinite intervals, and in particular, applications to Economics;

- Motion along a line, velocity and speed, acceleration, Position - time curve, Rolle's, Mean Value theorems and their consequences;
Indeterminate forms and L'Hospital's rule;

The topics to be discussed in this module can be found in chapter 2, 3 and 6 of text [1] below.

Module II - Methods of Integral Calculus (36 Hours)

The module should begin with revising integration techniques, like integration by substitution, fundamental theorem of calculus, integration by parts, integration by partial fractions, integration by substitution and the concept of definite integrals.

The above topics which can be found in chapter 4 and 7 of text [1] below are not to be included in the end semester examination.
A maximum of 5 hours should be devoted for the review of the above topics.
After this quick review, the main topics to discuss in this module are the following:

- Finding position, velocity, displacement, distance travelled of a particle by Integration, analyzing the distance-velocity curve, position and velocity when the acceleration is constant, analyzing the free-fall motion of an object, finding average value of a function and its applications;
- Area, volume, length related concepts : Finding area between two curves, finding volumes of some three dimensional solids by various methods like slicing, disks and washers, cylindrical shells, _finding length of a plane curve, surface of revolution and its area;
- Work done : Work done by a constant force and a variable force, relationship between work and energy;
- Relation between density and mass of objects, center of gravity, Pappus theorem and related problems
- Fluids, their density and pressure, fluid force on a vertical surface. Introduction to Hyperbolic functions and their applications in hanging cables; Improper integrals, their evaluation, applications such as finding arc length and area of surface.

The topics to be discussed in this module can be found in chapter 4, 5, 6 and 7 of text [1]below.

Text

Text 1: H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley& Sons

References

1. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company
2. J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited

SEMESTER I
Complementary course 1:ST 1131.1: Descriptive Statistics

Hours/week: 4

Aim and objectives

The course aims that students will learn to understand the characteristics of data and will get acquainted with describing data through illustrating examples and exercises. They will also learn to collect, organize and summarize data, create and interpret simple graphs and compute appropriate summary statistics.

Module I:

- **Part A: Introduction (Not for Examination Purpose):**
  - Significance of Statistics, Limitations and misuse of Statistics, Official Statistical system of India.
  - Types of Data: Concepts of primary data and secondary data, population and sample; Classification of data based on geographic, chronological, qualitative and quantitative characteristics.
- **Part B: Collection and Presentation of Data:**
  - Scales of data-Nominal, Ordinal, Ratio and Interval. Methods of collection of primary data–Preparation of questionnaires / schedules. Secondary data –major sources and limitations;
  - Census and Sample Surveys; Methods of sampling: Probability and non-probability sampling, simple random sampling with replacement (SRSWR) & simple random sampling without replacement (SRSWOR), Systematic sampling and Stratified sampling (concepts only); sampling and non-sampling errors;
  - Presentation of raw data: Classification and tabulation - Construction of Tables with one or more factors of classification, frequency distributions, relative and cumulative frequency distributions, their graphical representations.

Module II: Summarization of Data:

- Central tendency- mean, median, mode, geometric mean, harmonic mean; properties of Arithmetic Mean and Median; Relationship between AM, GM and HM;
- Absolute and relative measures of dispersion: Range, quartile deviation, mean deviation and standard deviation; Properties of mean deviation, standard deviation, combined mean and combined standard deviation; coefficient of variation;
- Moments- Raw and central moments; relationship between raw and central moments; effect of change of origin and scale; Skewness, Kurtosis and their measures.

Module III: **Bivariate data**:

- Scatter diagram, Fitting of curves- Principle of least squares, fitting of straight line, fitting parabola, curves $y=ab^x$, $y=ax^b$, $y=ae^{bx}$, and $y=ax^{-1}+b$.

Module IV:

- Regression lines and prediction, Karl Pearson's coefficient of correlation, Spearman's rank correlation.

Module V: Practical based on Modules I, II, III, & IV:

- Data analysis: presentation of data –Charts and Diagrams, Frequency table, Frequency graphs, calculation of descriptive statistics, curve fitting, correlation and regression.

References

1. Gupta S.C. and Kapoor V.K. (1980). *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons, New Delhi.
2. Gupta, S. C., and Kapoor, V. K. (1994). *Fundamental of Mathematical Statistics*. Sultan Chand & Sons, New Delhi.
3. Gupta S. P. (2004). *Statistical Methods*. Sultan Chand & Sons, New Delhi.
4. Kenny J. F & Keeping E. S (1964). *Mathematics of Statistics –Part Two*. 2nd Edition, D. Van Nostard Company, New Delhi-1.
5. Kenny J. F (1947). *Mathematics of Statistics Part One*. 2nd Edition, D. Van Nostard Company, New Delhi-1.
6. Mukhopadhyay, P. (1996). *Mathematical Statistics*. New Central Book Agency (P) Ltd, Calcutta.
7. Agarwal, B.L. (2006). *Basic Statistics*. 4th Edition New Age international (P) Ltd., New Delhi.
8. Agarwal, B.L.(2013). *Basic Statistics*. Anshan, Uk

SEMESTER II

Foundation course II: MM 1221 Foundations of Mathematics

Instructional hours per week: 4 No.of credits: 3

Aim and objectives

The rigorous study of mathematics begins with understanding the concepts of sets and functions. After that, one needs to understand the way in which a mathematician formally makes statements and proves or disproves it. We start this course with an introduction to these fundamental concepts. Apart from that, the basic of vector calculus is to be revised before moving to more advanced topics.

Module I - Foundations of Logic and Proof (36 Hours)

- Statements, logical connectives, and truth tables, conditional statements and parts of it, tautology and contradiction, using various quantifiers like universal and existential quantifiers in statements, writing negations, determining truth value of statements;
- Proof : Various techniques of proof like inductive reasoning, counter examples, deductive reasoning, hypothesis and conclusion, contrapositive statements, converse statements, contradictions, indirect proofs;

- Sets and relations: A review of basic set operations like union, intersection, subset, superset concepts, equality of sets, complements, disjoint sets, indexed family of sets and operations on such families, ordered pairs, relations on sets, Cartesian products (finite case only), various types of relations (reflexive, symmetric, transitive, equivalence), partitions of sets;

- Functions: domain, codomain, range of functions, one-one, onto, bijective functions, image, pre image of functions, composing functions and the order of composition, inverse functions, cardinality of a set, equinumerous (equipotent) sets

The topics to be discussed in this module can be found in chapter 1 and 2 of text [1] below.

Module II - Foundations of co-ordinate geometry (18 Hours)

- Parametric equations of a curve, orientation of a curve, expressing ordinary functions parametrically, tangent lines to parametric curves, arc length of parametric curves;

- Polar co-ordinate systems, converting between polar and rectangular co-ordinate systems, graphs in the polar co-ordinate system, symmetry tests in the polar co-ordinate system, families of lines, rays, circles, other curves, spirals;

- Tangent lines to polar curves, arc length of the curve, area, intersections of polar Curves;

- Conic sections : definitions and examples, equations at standard positions, sketching them, asymptotes of hyperbolas, translating conics, reflections of conics, applications, rotation of axes and eliminating the cross product term from the equation of a conic, polar equations of conics, sketching them, applications in astronomy such as Kepler's laws, related problems

The topics to be discussed in this module can be found in chapter 10 of text [2] below.

Module III - Foundations of vector calculus (18 Hours)

- To begin with, the three dimensional rectangular co-ordinate system should be discussed and how distance is to be calculated between points in this system. Basic operations on vectors like their addition, cross and dot products should be introduced next. The concept of projections of vectors and the relation with dot product should be given emphasize. Equations of lines determined by a point and vector, vector equations in lines, equations of planes using vectors normal to be should be discussed.

- Quadric surfaces which are three dimensional analogues of conics should be discussed next. Various co-ordinate systems like Cylindrical, spherical should be discussed next with the methods for conversion between various co-ordinate systems.

The topics to be discussed in this module can be found in chapter 11 of text [2] below.

Texts

Text 1- S R Lay. Analysis with an Introduction to Proof, 5th Edition, Pearson Education Limited
Text 2- H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons

References

1. J P D'Angelo, D B West. Mathematical Thinking - Problem Solving and Proofs, 2nd Edition, Prentice Hall
2. Daniel J Velleman. How to Prove it : A Structured Approach, 2nd Edition, Cambridge University Press
3. Elena Nardi, Paola lannonne. How to Prove it : A brief guide for teaching Proof to Year 1 mathematics undergraduates, University of East Anglia, Centre for Applied Research in Education
4. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company
5. J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited

SEMESTER II
ST 1231.1: Probability and Random variables

Hours/week: 4

Aim

This course will introduce the elementary ideas of probability and random variables.

Module I: Random experiments:

- Sample point and sample space- Events, algebra of events, concepts of equally likely, mutually exclusive and exhaustive events;
- Probability: Statistical regularity, relative frequency and classical approaches, Axiomatic approach, theorems in probability, probability space.

Module II:

- Conditional probability, multiplication theorem, independence of two and three events, compound probability, Bayes' theorem and its applications.

Module III: **Random variables**:

- Discrete and continuous, probability mass function and probability density function, distribution function, joint distribution of two random variables, marginal and conditional distributions, independence, transformation of variables-one-to-one transformation-univariate.

Module IV:

- Expectation of random variables and its properties, theorems on expectation of sums and product of independent random variables, conditional expectation, moments, moment generating function, characteristic function their properties and uses; bivariate moments, Cauchy- Schwartz inequality and correlation coefficient.

Module V: Practical (Numerical Problems) based on Modules I, II, III, & IV

- -random variables (univariate and bivariate), expectations and moments.

References

1. Bhat B.R. (1985). *Modern Probability Theory*. New Age International (P) Ltd, New Delhi.
2. Dudewicz E.J and Mishra S.N (1988). *Modern Mathematical Statistics*. John Wiley & Sons, New York.
3. Gupta, S. C., and Kapoor, V. K. (1994). *Fundamental of Mathematical Statistics*. Sultan Chand & Sons. New Delhi.
4. Pitman, J. (1993). *Probability*. Narosa Publishing House, New Delhi

5. Mukhopadhyay, P. (1996). *Mathematical Statistics*. New Central Book Agency (P) Ltd, Calcutta.
6. Rohatgi V. K.(1993). *An Introduction to Probability Theory and Mathematical Statistics*. Wiley Eastern, New Delhi.
7. Rao C.R (1973). *Linear Statistical Inference and its Applications*. 2/e, Wiley, New York.

SEMESTER III

MM 1341 Elementary Number Theory and Calculus I

Instructional hours per week: 5 No.of credits: 4

Aim and objectives

Towards beginning the study on abstract algebraic structures, this course introduces the fundamental facts in elementary number theory. Apart from that, calculus of vector valued functions and multiple integrals is also discussed.

Module I - Divisibility in integers (18 Hours)

The topic of elementary number theory is introduced for further developing the ideas in abstract algebra. The following are the main topics in this module:

- The division algorithm, Pigeonhole principle, divisibility relations, inclusion-exclusion principle, base-b representations of natural numbers, prime and composite numbers, infinitude of primes, GCD, linear combination of integers, pairwise relatively prime integers, the Euclidean algorithm for finding GCD, the fundamental theorem of arithmetic, canonical decomposition of an integer into prime factors, LCM; Linear Diophantine Equations and existence of solutions, Eulers Method for solving LDE's

The topics to be discussed in this module can be found in chapter 2 and 3 of text [2] below.

Module II - Vector valued functions (30 Hours)

Towards going to the calculus of vector valued functions, we define such functions. The other topics in this module are the following:

- Parametric curves in the three dimensional space, limits, continuity and derivatives of vector valued functions, geometric interpretation of the derivative, basic rules of differentiation of such functions, derivatives of vector products, integrating vector functions, length of an arc of a parametric curve, change of parameter, arc length parameterizations,
- various types of vectors that can be associated to a curve such as unit vectors, tangent vectors, binormal vectors, definition and various formulae for curvature, the geometrical interpretation of curvature, motion of a particle along a curve and geometrical interpretation of various vectors associated to it, various laws in astronomy like Kepler's laws and problems

The topics to be discussed in this module can be found in chapter 12 of text [1] below.

Module III - Multivariable Calculus (42 Hours)

After introducing the concept of functions of more than one variable, the sketching of them in three dimensional cases with the help of level curves should be discussed.

- Countours and level surface plotting also should be discussed. The other topics in this module are the following:
- Limits and continuity of Multivariable functions, various results related to finding the limits and establishing continuity, continuity at boundary points, partial derivatives of functions, partial derivative as a function, its geometrical interpretation, implicit partial differentiation, changing the order of partial differentiation and the equality conditions; Differentiability of a multivariate function, differentiability of such a function implies its continuity, local linear approximations, chain rules - various versions,
- directional derivative and differentiability, gradient and its properties, applications of gradients;
- Tangent planes and normal vectors to level surfaces, finding tangent lines to intersections of surfaces, extrema of multivariate functions, techniques to find them, critical and saddle points, Lagrange multipliers to solve extremum problems with constrains,

The topics to be discussed in this module can be found in chapter 13 of text [1] below.

<u>Texts</u>

Text 1-H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons
Text 2 -Thomas Koshy. Elementary Number Theory with Applications,
2nd Edition,Academic press

<u>References</u>

1. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley PublishingCompany
2. J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited
3. G A Jones, J M Jones. Elementary Number Theory, Springer

SEMESTER III

ST 1331.1: Statistical Distributions

Hours/week: 5

This course introduces standard probability distributions, limit theorems and sampling distributions.

Module I: Standard Distributions (Discrete):

- Uniform, binomial, Poisson and geometric- moments, moment generating function, characteristic function, problems, additive property (binomial and Poisson), recurrence relation (binomial and Poisson), Poisson as a limiting form of binomial, memory less property of geometric distribution;
- Fitting of binomial and Poisson distributions; hyper geometric distribution (definition, mean and variance only).

Module II: Standard Distributions (Continuous):

- Uniform, exponential, and gamma - moment generating function, characteristic function, problems; memory less property of exponential distribution; additive property of gamma distribution; beta distribution (I and II)- moments, Normal distribution- moments, moment generating function, characteristic function, problems, recurrence relation of central moments; convergence of binomial and Poisson to normal.

Module III:

- Chebychev's inequality; Law of large numbers-BLLN, convergence in probability (definition only), WLLN; central limit theorem for iid random variables- statement and applications.

Module IV

- Parameter and statistic, Sampling distributions- Distribution of mean of a sample taken from a normal population, Chi-square($\chi2$)- definition and properties, t and F distributions (definitions only) and statistics following these distributions, relation between normal, $\chi2$, t and F distributions.

Module V:

- Practical based on Modules I, II, III, & IV – Discrete and continuous probability distributions and applications, law of large numbers and CLT.

References

1. Medhi J.(2005). *Statistical Methods-An Introductory Text*. New Age International (P) Ltd, New Delhi.
2. Gupta S.C. and Kapoor V.K. (1980). *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons, New Delhi.
3. John E. Freund(1980). *Mathematical Statistics*. Prentice Hall of India, New Delhi.
4. Mukhopadhyay, P. (1996). *Mathematical Statistics*. New Central Book Agency (P) Ltd, Calcutta.
5. Rohatgi V. K.(1993). *An Introduction to Probability Theory & Mathematical Statistics*. Wiley-Eastern, New Delhi.

SEMESTER IV

MM 1441 Elementary Number Theory and Calculus II

Instructional hours per week: 5 No.of credits: 4

Aim and objectives

As in the previous semester, towards beginning the study on abstract algebraic structures, this course introduces the fundamental facts in elementary number theory. Apartfrom that, calculus of vector valued functions and multiple integrals is also discussed.

Module I - Congruence relations in integers (30 Hours)

- Towards defining the congruence classes in Z, we begin with defining the congruence relation. Its various properties should be discussed, and then the result that no prime of the form 4n + 3 is a sum of two squares should be discussed. The other topics in this module are the following:
- Defining congruence classes, complete set of residues, modulus exponentiation, finding reminder of big numbers using modular arithmetic, cancellation laws in modular arithmetic, linear congruence's and existence of solutions, solving Mahavira's puzzle, modular inverses, Pollard Rho factoring method;
- Certain tests for divisibility - The numbers here to test are powers of 2, 3, 5, 7, 9, 10,11, testing whether a given number is a square; Linear system of congruence equations, Chinese Remainder Theorem and some applications;
- Some classical results like Wilson's theorem, Fermat's little theorem, Pollard p – 1 factoring method, Euler's' theorem,

The topics to be discussed in this module can be found in chapter 2 and 3 of text [2] below.

Module II - Multiple integrals (30 Hours)

Here we discuss double and triple integrals and their applications. The main topics in this module are the following:

- Double integrals: Defining and evaluating double integrals, its properties, double integrals over non rectangular regions, determining limits of integration, revising the order of integration, area and double integral, double integral in polar coordinates and their evaluation, finding areas using polar double integrals, conversion between rectangular to polar integrals, finding surface area, surface of revolution in parametric form, vector valued function in two variables, finding surface area of parametric surfaces;
- Triple integrals : Properties, evaluation over ordinary and special regions, determining the limits, volume as triple integral, modifying order of evaluation, triple integral in cylindrical co-ordinates, Converting the integral from one co-ordinate system to other;
- Change of variable in integration (single, double, and triple), Jacobians in two variables.

The topics to be discussed in this module can be found in chapter 14 of text [1] below.

Module III - Vector Calculus (30 Hours)

After the differentiation of vector valued functions in the last semester, here we introduce the concept of integrating vector valued functions. Some important theorems are also to be discussed here. The main topics are the following:

- Vector fields and their graphical representation, various type of vector fields (inverse-square, gradient, conservative), potential functions, divergence, curl, the Δ operator ,Laplacian;
- Integrating a function along a curve (line integrals), integrating a vector field along a curve, defining work done as a line integral, line integrals along piecewise-smooth curves,
- integration of vector fields and independence of path, fundamental theorem of line integrals, line integrals along closed paths, test for conservative vector fields, Green's theorem and applications;
- Defining and evaluating surface integrals, their applications, orientation of surfaces, evaluating flux integrals, The divergence theorem, Gauss' Law, Stoke's theorem, applications of these theorems.

The topics to be discussed in this module can be found in chapter 15 of text [1] below.

Texts

Text 1- H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons

Text 2- Thomas Koshy. Elementary Number Theory with Applications, 2nd Edition,Academic Press

References

1. G B Thomas, R L Finney. Calculus, 9th Edition, Addison-Weseley Publishing Company
2. J Stewart. Calculus with Early Transcendental Functions, 7th Edition, Cengage India Private Limited
3. G A Jones, J M Jones. Elementary Number Theory, Springer

ST 1431.1: Statistical Inference

Hours/week: 5

This course enables the students to understand the methods of Statistical Inference.

Module I:

- Point estimation, Properties of estimators – unbiasedness, consistency, efficiency and sufficiency; Methods of estimation - Maximum likelihood method, method of moments; Interval estimation of mean, variance and proportion (single unknown parameter only).

Module II:

- Testing of Hypothesis- statistical hypotheses, simple and composite hypotheses, two types of errors, significance level, p-value, power of a test, Neyman-Pearson lemma (without proof).

Module III:

- Large sample tests- testing mean and proportion (one and two sample cases), Chi-square (χ2) test of goodness of fit, independence and homogeneity.
- Small sample tests- Z-test for means; One sample test for mean of a normal population, Equality of means of two independent normal populations, Paired samples t-test, Chi-square test for variance, F-test for equality of variances.

Module IV:

- Design of Experiments- assumptions, principles, models and ANOVA tables of one way and two way classified data (Derivation of two – way model is not included).

Module V: Practical based on Modules I, II, III & IV.

References

1. Das M. N., Giri N. C. (2003). *Design and analysis of experiments*. New Age International (P) Ltd, New Delhi.
2. John E. Freund (1980). *Mathematical Statistics*. Prentice Hall of India, New Delhi.
3. Medhi J. (2005). *Statistical Methods-An Introductory Text*, New Age International (P) Ltd... New Delhi.
4. Paul G. Hoel, Sidney C. Port, Charles J. Stone (1971). *Introduction to Statistical Theory*. Universal Book stall, New Delhi.

Course V - ST 1432.1: Practical using Excel

The students will learn to use statistical tools available in Excel and have hands on training in data analysis. This course covers topics of courses I, II, III & IV.
Use of Excel in statistics (Charts, functions and data analysis),
Practical covering Semesters I, II, III, & IV

Section I: **Charts- Bar chart, Pie chart & scatter diagram**

Functions- Evaluation of numerical problems using the following functions
AVEDEV AVERAGE BINORMDIST CHIDIST CHINV CHITEST
CONFIDENCE CORREL COVAR DEVSQ FDIST FINV
FREQUENCY FTEST GEOMEAN HARMEAN INTERCEPT KURT
MEDIAN MODE LINEST LOGEST NORMDIST NORMINV
NORMSDIST PEARSON POISSON PROB SKEW SLOPE
STANDARDIZE STDEV P TDIST TINV TREND TTEST

Section II: Data analysis

Histogram, Descriptive Statistics, Covariance, Correlation, Regression, Random Number Generation, Sampling, t-tests for means: Paired t-test, Equality of means of two normal populations, z-test: Two Sample test for Means, F-test for Variances, ANOVA- Single Factor and Two Factor without Replication.

References

1. Dan Remenyi, George Onofrei, Joe English (2010). *An Introduction to Statistics Using Microsoft Excel*.
Academic Publishing Ltd., UK
2. Neil J Salkind (2010). *Excel Statistics, A Quick Guide*. SAGE Publication Inc. New Delhi
3.Vijai Gupta (2002). *Statistical Analysis with Excel*. VJ Books Inc. Canada

Record of Practical

Duly certified record of practical sessions is mandatory to appear for the practical examination. Five questions are to be worked out in each sheet based on the topics given below:

Sheets

1. Diagrams and Graphs
2. Measures of Central Tendency and Dispersion
3. Moments, Skewness and Kurtosis
4. Fitting of Curves
5. Correlation and Regression
6. Probability
7. Univariate Random Variables
8. Bivariate Random Variables
9. Mathematical Expectation
10. Bivariate Moments
11. Standard Distributions- Discrete
12. Standard Distributions- Continuous
13. Law of Large Numbers
14. Sampling Distributions
15. Point Estimation
16. Interval Estimation
17. Large Sample Tests
18. Small Sample Tests
19. Analysis of Variance
20. Charts in Excel
21. Functions in Excel
22. Analysis Tools in Excel

Print-out of output of practical sheets 20, 21 and 22 are to be attached. CE and ESE marks are to be awarded and consolidated as per regulations of the FDP in affiliated Colleges, 2013.

SEMESTER V

MM 1541 Real Analysis I

Instructional hours per week: 5 No.of credits: 4

Aim and objectives

- In this course, we discuss the notion of real numbers, the ideas of sequence of real numbers and the concept of infinite summation in a formal manner. Many of the topics discussed in the first two modules of this course were introduced somewhat informally in earlier courses, but in this course, the emphasis is on mathematical rigor.
- A minimal introduction to the metric space structure of R is also included so as to serve as a step-ping stone into the idea of abstract topological spaces. The course is mainly based on Chapters 1{3 of text [1].
- All the chapters mentioned above contains a section titled *Discussions* in the beginning of the chapter. This section is intended only for motivating the students, and so should not be made as a part of the examination process.

Module I (25 Hours)

This module introduces the basic concepts about the real number system with some introduction to sets, functions, and proof techniques. The following are the main topics to be discussed:

- existence of an irrational number, the axiom of completeness, upper lower bounds of sets in R, consequences of completeness like Archimedean property of real numbers,
- Density of Q in R, existence of square roots, countability of Q and uncoubtability of R, various cardinality results, Cantor's original proof for uncoubtability of R, and Cantor's theorem on power sets.

The topics to be discussed in this module can be found in chapter 1 of text [1] below. The first section 1.1 may be briefly discussed and is not meant for examination purposes.

Module II (40 hours)

Students must have already encountered the idea of infinite series through the example of geometric progression. After discussing the rearrangement concept of infinite series, the following topics are to be introduced rigorously:

- Limit of a sequence, diverging sequences, examples, algebraic operations on limits, and order properties of sequences and limits, the Monotone Convergence Theorem, Cauchy's condensation test for convergence of a series, various other tests for the convergence series, the Bolzano-Weierstrass theorem, and the Cauchy criterion for convergence of a sequence, rearrangement of absolutely convergent series.

The topics to be discussed in this module can be found in chapter 2 of text [1] below. The \first section 2.1 may be briefly discussed and is not meant for examination purposes.

Module III (25 hours)

This module is intended to be a beginner for learning abstract metric spaces. To motivate the students, the Cantor set should be constructed and shown in the beginning. Then move to the topics open and closed sets in R, and what about their complements,

- Compactness of sets (defined using sequential convergence), open covers and compactness, perfect and connected sets in R, and finally the Baire's theorem.

The topics to be discussed in this module can be found in chapter 3 of text [1] below. The first section 3.1 may be briefly discussed and is not meant for examination purposes.

Texts

Text 1- Stephen Abbot. Understanding Analysis, 2nd Edition, Springer

References

1. G Bartle, D Sherbert. Introduction to Real Analysis, 3rd Edition, John Wiley & Sons
2. W. Rudin. Principles of Mathematical Analysis, Second Edition, McGraw-Hill
3. Terrence Tao. Analysis I, Hindustan Book Agency

IMM 1542 Complex Analysis

Instructional hours per week: 4 No.of credits: 3

Here we go through the basic complex function theory.

Module I (27 Hours)

- Complex numbers : The algebra of Complex Numbers, Point Representation of ComplexNumbers, Vectors and Polar forms, The Complex Exponential, Powers and Roots, Planar Sets
- Analytic Functions : Functions of a complex variable, Limits and Continuity, Analyticity,The Cauchy Riemann Equations, Harmonic Functions

The topics to be discussed in this module can be found in chapter 1, sections 1.1, 1.2, 1.3,1.4, 1.5, 1.6 and chapter 2, sections 2.1, 2.2, 2.3, 2.4, 2.5 of text [1] below.

Module II (15 hours)

- Elementary Functions: Polynomials and rational Functions (Proof of the theorem on partial fraction decomposition need not be discussed), The Exponential, Trigonometric and Hyperbolic Functions, The Logarithmic Function, Complex Powers and Inverse Trigonometric Functions.

The topics to be discussed in this module can be found in chapter 3, sections 3.1, 3.2, 3.3,3.5 of text [1] below.

Module III (30 hours)

- Complex Integration : Contours, Contour Integrals, Independence of Path, Cauchy's Integral Theorem (Section 4.4a on deformation of Contours Approach is to be discussed, but section 4.4 b on Vector Analysis Approach need not be discussed), Cauchy's Integral Formula and Its Consequences, Bounds of Analytic Functions

The topics to be discussed in this module can be found in chapter 4, sections 4.1, 4.2, 4.3,4.4a, 4.5 and 4.6 of text [1] below

.

Texts

Text 1-Edward B. Sa_, Arthur David Snider. Fundamentals of complex analysis with applications to engineering and science, 3rd Edition, Pearson Education India

References

1. John H Mathews, Russel W Howell. Complex Analysis for Mathematics and
2. Engineering, Jones and Bartlett Publishers
3. Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India
4. James Brown, Ruel Churchill. Complex Variables and Applications, Eighth Edition, McGraw-Hill

MM 1543 Abstract Algebra I -Group Theory

Instructional hours per week: 5 No. of credits: 4

Aim and objectives

- The aim of this course is to provide a very strong foundation in the theory of groups.
- All the concepts appearing in the course are to be supported by numerous examples mainly from the references provided.

Module I (30 Hours)

- The concept of group is to be introduced before rigorously defining it. The symmetries of a square can be a starting point for this. After that, definition of group should be stated and should be clarified with the help of examples. After discussing various properties of groups, finite groups and their examples should be discussed. The concept of subgroups with various characterizations also should be discussed. After introducing the definition of cyclic groups, various examples, and important features of cyclic groups and results on order of elements in such groups should be discussed

.

The topics to be discussed in this module can be found in chapter 1, 2 3 and 4 of text [1] below.

Module II (24 Hours)

- This module starts with defining and analyzing various properties permutation groups which forms one of the most important class of examples for non abelian, finite groups.
- After defining operations on permutations, their properties are to be discussed. To motivate the students, the example of check-digit scheme should be discussed (This section on check-digit scheme is not meant for the examinations). Then we proceed to define the notion of equivalence of group's viz. isomorphism. Several examples are to be discussed for explaining this notion. The properties of isomorphism's are also to be discussed together with special classes of isomorphisms like automorphisms and inner automorphisms before finishing the module with the classic result of Cayley on finite groups.

The topics to be discussed in this module can be found in chapter 5 and 6 of text [1] below.

Module III (18 Hours)

In this module we prove one of the most important results in group theory which is the Lang range's theorem on counting cosets of a finite group. The concept of cosets of a group should be defined giving many examples before proving the Lagrange's theorem. As some of the applications of this theorem, the connection between permutation groups and rotations of cube and soccer ball should be discussed. The section on Rubik's cube and section on internal direct products need not be discussed.

The topics to be discussed in this module can be found in chapter 7 and 9 of text [1] below.

Module IV (18 Hours)

- Here the concept of group homomorphisms should be defined with sufficient number of examples. After proving the first isomorphism theorem, the fundamental theorem of isomorphism should be introduced and proved. Classifying groups based on the fundamental theorem should be discussed in detail.

The topics to be discussed in this module can be found in chapter 10 and 11 of text [1] below.

Texts

Text 1-Joseph Gallian. Contemporary Abstract Algebra, 8th Edition, Cengage Learning

References

1. D S Dummit, R M Foote. Abstract Algebra, 3rd Edition, Wiley
2. I N Herstein. Topics in Algebra, Vikas Publications

MM 1544 Differential Equations

Instructional hours per week: 3 No.of credits: 3

Aim and objectives

- In this course, we discuss how differential equations arise in various physical problems and consider some methods to solve first order differential equations and second order linear equations. For introducing the concepts, text [1] may be used, and for strengthening the theoretical aspects, reference [1] may be used.

Module I - First order ODE (18 hours)

In this module we discuss first order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly.

The main topics in this module are the following:

- Modelling a problem, basic concept of a differential equation, its solution, initial value problems, geometric meaning (direction fields), separable ODE, reduction to separable form, exact ODEs and integrating factors, reducing to exact form, homogeneous and non-homogeneous linear ODEs, special equations like Bernoulli equation, orthogonal trajectories, understanding the existence and uniqueness of solutions theorem.

The topics to be discussed in this module can be found in chapter 1 of text [1] below.

Module II - Second order ODE (18 hours)

As in the first module, we discuss second order equations and various methods to solve them. Sufficient number of exercises also should be done for understanding the concepts thoroughly.
The main topics in this module are the following:

- Homogeneous linear ODE of second order, initial value problem, basis, and general solutions, finding a basis when one solution is known, homogeneous linear ODE with constant coefficients (various cases that arise depending on the characteristic equation), differential operators, Euler-Cauchy Equations, existence and uniqueness of solutions w.r. to wronskian, solving non homogeneous ODE via the method of undetermined coefficients, various applications of techniques, solution by variation of parameters

.

The topics to be discussed in this module can be found in chapter 2 of text [1] below.

Texts

Text 1-Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India

References

1. G. F. Simmons. Di_erential Equations with applications and Historical notes, Tata McGraw-Hill, 2003
2. H Anton, I Bivens, S Davis. Calculus, 10th Edition, John Wiley & Sons
3. Peter V. O' Neil. Advanced Engineering Mathematics, Thompson Publications, 2007

MM 1545 Mathematics Software - LATEX & Sage Math

Instructional hours per week: 4 No.of credits: 3

Aim and objectives

Here we introduce two software which are commonly used by people working in Mathematics. A science typesetting software **LATEX,** and a mathematical computation and visualization software **Sage Math.**

- The aim of introducing LATEX software is to enable students to typeset the project report which is a compulsory requirement for finishing their undergraduate mathematics program successfully.
- The aim of learning Sage Math is to enable students to see how the computational techniques they have learned in the previous semesters can be put into action with the help of software so as to reduce human effort. Also, they should be able to use this software for further computations in their own in the forthcoming semester.

Module I - LATEX for preparing a project report in Mathematics (36 Hours)

- Graphical User Interface (GUI)/ Editor like Kile or TeXstudio should be used for providing training to the students. The main topics in this module are following:
- Typesetting a simple article and compiling it;
- How spaces are treated in the document;
- Document layout : various options to be included in the document class command,page styles, splitting files into smaller files, breaking line and page, using boxes (like,mbox) to keep text unbroken across lines, dividing document in to parts like frontmatter, mainmatter, backmatter, chapters, sections, etc, cross referencing with and without page number, adding footnotes;
  Emphasizing words with \emph, \texttt, \textsl, \textit, \underline etc.
  Basic environments like enumerate, itemize, description, flushleft, flusuright,
  Center, quote, quotation
- Controlling enumeration via the enumerate package.
- Tables : preparing a table and floating it, the long table environment;
- Typesetting mathematics : basic symbols, equations, operators, the equation environment and reference to it, the display math environment, exponents, arrows, basic functions, limits, fractions, spacing in the mathematics environments, matrices, aligning various objects, multi-equation environments, suppressing numbering for one or more equations, handling long equations, phantoms, using normal text in math mode, controlling font size, typesetting theorems, definitions, lemmas, etc., making text bold in math mode, inserting symbols and environments (**array, pmatrix e**tc) using the support of **GUIs;**
- Figures : Including **JPG, PNG** graphics with graphicx package, controlling width, height etc., floating figures, adding captions, the wrap fig package;

- Adding references/bibliography and citing them, using the package **hyper ref** to add and control hypertext links, creating presentations with **pdfscreen,** creating new commands;
- Fonts : changing font size, various fonts, math fonts,

- Spacing : changing line spacing, controlling horizontal, vertical spacing, controlling the margins using the geometry package, fullpage package
- Preparing a dummy project with **titlepage,** acknowledgement, certificates, table ofcontents (using **\tableofcontents),** list of tables, table of figures, chapters, sections, bibliography (using **thebibliography** environment). This dummy project should contain atleast one example from the each of the topic in the syllabus, and should be submitted for internal evaluation before the end semester practical examination.

Module II - Doing Mathematics with SageMath (36 hours)

<u>Aim and objectives</u>

Starting Sage Math using a browser, how to use the sage cell server https://sagecell. sagemath.org/, how to use SageMathCloud, creating and saving a sage worksheet, saving the worksheet to an .SWs file, moving it and re-opening it in another computer system;

Using sage math as a calculator, basic functions (square root, logarithm, numeric value, Exponential, trigonometric, conversion between degrees and radians, etc.);

- Plotting : simple plots of known functions, controlling range of plots, controlling axes, labels, gridlines, drawing multiple plots on a single picture, adding plots, polar plotting, plotting implicit functions, contour plots, level sets, parametric 2D plotting, vector fields plotting, gradients;

- Matrix Algebra : Adding, multiplying two matrices, row reduced echelon forms to solve linear system of equations, finding inverses of square matrices, determinants, exponentiation of matrices, computing the kernel of a matrix;

- Defining own functions and using it, composing functions, multi variate functions;

- Polynomials : Defining polynomials, operations on them like multiplication and division, expanding a product, factorizing a polynomial, finding gcd;
- Solving single variable equations, declaring multiple variables, solving multi variable equations, solving system of non-linear equations, finding the numerical value of roots of equations;
- complex number arithmetic, finding complex roots of equations;

- Finding derivatives of functions, higher order derivatives, integrating functions, definite and indefinite integrals, numerical integration, partial fractions and integration,

- Combinations & Number theory: Permutations, combinations, finding gcd, lcm, prime factorization, prime counting function, nth prime function, divisors of a number, counting divisors, modular arithmetic;

- Vector calculus : Defining vectors, operations like sum, dot product, cross product, vector valued functions, divergence, curl, multiple integrals;

- Computing Taylor, McClaurins polynomials, minimization and Lagrange multipliers, constrained and unconstrained optimization;

Internal Evaluation: A dummy project report prepared in LATEX should be submitted as assignment for internal evaluation for 5 marks. Another practical record should be submitted the content of which should be problems and their outputs evaluated using Sage Math. This record should be awarded a maximum of 10 marks which is earmarked for the internal evaluation examination.

Problems to be included in the examination:
1. Find all local extrema and inflection points of a function
2. Traffic flow optimization
3. Minimum surface area of packaging
4. Newton's method for finding approximate roots
5. Plotting and finding area between curves using integrals
6. Finding the average of a function
7. Finding volume of solid of revolution
8. Finding solution for a system of linear equations
9. Finding divergence and curl of vector valued functions
10. Using differential calculus to analyze a quintic polynomials features, for finding the optimal graphing window
11. Using Pollard's p -1 Method of factoring integers, to try to break the RSA cryp-
To system
12. Expressing gcd of two integers as a combination of the integers (Bezout's identity)

References

1. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl. *The (Not So)*
    a. *Short Introduction to LATEX2e*, Samurai Media Limited (or available online at
    b. *http://mirrors.ctan.org/info/lshort/english/lshort.pdf)*
2. Leslie Lamport. LATEX: A Document Preparation System, Addison-Wesley, Reading, Massachusetts, second edition, 1994
3. LATEX Tutorials|A Primer, Indian TeX Users Group, available online at https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf
4. H. J. Greenberg. A Simpli_ed introduction to LATEX, available online at https://www.ctan.org/tex-archive/info/simplified-latex/
5. Using Kile - KDE Documentation, https://docs.kde.org/trunk4/en/extragear-office/kile/quick_using.html
6. TeXstudio : user manual, http://texstudio.sourceforge.net/manual/current/usermanual_en.html
7. The longtable package - TeXdoc.net, http://texdoc.net/texmf-dist/doc/latex/tools/longtable.pdf
8. wrap_g - TeXdoc.net, http://texdoc.net/texmf-dist/doc/latex/wrapfig/wrapfig-doc.pdf
9. The geometry package, http://texdoc.net/texmf-dist/doc/latex/geometry/geometry.pdf

(Open Course)
MM 1551 Operations Research

Instructional hours per week: 3 No. of Credits: 2

Module I: Linear Programming (18 hours)

- Formulation of Linear Programming models, Graphical solution of Linear Programs in two variables, Linear Programs in standard form - basic variable - basic solution- basic feasible solution -feasible solution, Solution of a Linear Programming problem using simplex method (Since Big-M method is not included in the syllabus, avoid questions in simplex method with constraints of $\geq$or = type.)

Module II: Transportation Problems (18 hours)

- Linear programming formulation - Initial basic feasible solution (Vogel's approximation method/North-west corner rule) - degeneracy in basic feasible solution - Modified distribution method - optimality test.

- Assignment problems: Standard assignment problems - Hungarian method for solving an assignment problem.

Module III: Project Management (18 hours)

- Activity -dummy activity - event - project network, CPM (solution by network analysis only), PERT.

The topics to be discussed in this course can be found in text [1].

<u>Texts</u>

Text 1- Ravindran, Philps, Solberg. Operations Research- Principles and Practice, 2nd Edition, Wiley India Pvt Ltd

<u>References</u>

1. Hamdy A. Taha. Operations Research : An Introduction, 9th Edition, Pearson

SEMESTER VI

MM 1641 Real Analysis – II

Instructional hours per week: 5 No.of credits: 4

Aim and objectives

In the second part of the Real Analysis course, we focus on functions on R, their continuity, existence of derivatives, and integrability. The course is mainly based on chapters 4, 5 and 7 of text [1].

All the chapters mentioned above contains a section titled Discussions in the beginning of the chapter. These sections are intended only for motivating the students, and so should not be made a part of the examination process.

Module I (35 Hours)

Here we move towards the basic notion of limits of functions and their continuity. Various version of definition of limits are to be discussed here.

- The algebra of limits of functions and the divergence criterion for functional limits are to be discussed next.
- The other topics to be discussed in this module are the discontinuity criterion, composition of functions and continuity, continuity and compact sets, results on uniform continuity, the intermediate value theorem, Monotone functions and their continuity.

The topics to be discussed in this module can be found in chapter 4 of text [1] below. The first section 4.1 may be briefly discussed and is not meant for examination purposes.

Module II (25 hours)

Here we discuss the derivative concept more rigorously than what was done in the previous calculus courses. After (re)introducing the definition of differentiability of functions, we verify that differentiability implies continuity. Algebra and composing of differentiable functions should be discussed next.

- The interior extremum theorem and Darboux's theorem should be discussed after that. The mean value theorems should be discussed and proved, and the module ends with L' Hospital's results. A continuous everywhere but nowhere differentiable function should be discussed, but it is not meant for the examination. It may be infact used for student seminars.

The topics to be discussed in this module can be found in chapter 5 of text [1] below. The sections 5.1 and 5.4 may be briefly discussed and is not meant for examination purposes.

Module III (30 hours)

In the last module, the theory of Riemann integration is to be discussed. Main topics to be included in this module are

- defining the Riemann integral using upper, lower Riemann sums, and the integrability criterion, continuity and the existence of integral, algebraic operations on integrable functions, (The results and examples on convergence of sequence of functions and integrability may be omitted), the fundamental theorem of calculus and its proof, Lebesgue's criterion for Riemann integrability.

The topics to be discussed in this module can be found in chapter 7 of text [1] below. The first section 7.1 may be briefly discussed and is not meant for examination purposes.

Texts

Text 1-Stephen Abbot; Understanding Analysis, 2nd Edition, Springer

References

1. R G Bartle, D Sherbert ; Introduction to real analysis, 3rd Edition, John Wiley & Sons
2. W. Rudin, Principles of Mathematical Analysis, Second Edition, McGraw-Hill
3. Terrence Tao; Analysis I, Hindustan Book Agency

MM 1642 Complex Analysis II

Instructional hours per week: 4 No.of credits: 3

Module I (32 Hours)

- Series Representations for Analytic Functions: Sequences and Series, Taylor Series, Power Series, Mathematical Theory of Convergence, Laurent series, Zeros and Singularities, The point at Infinity. The topics to be discussed in this module can be found in chapter 5, sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 of text [1] below.

Module II (20 Hours)

- Residue Theory : The Residue Theorem, Trigonometric Integrals over [0; 2_], Improper integrals of Certain functions over [□1;1], Improper integrals involving Trigonometric Functions, Indented Contours

The topics to be discussed in this module can be found in chapter 6, sections 6.1, 6.2, 6.3,6.4, 6.5 of text [1] below.

Module III (20 Hours)

- Conformal Mapping : Geometric Considerations, Mobius Transformations. The topics to be discussed in this module can be found in chapter 7, sections 7.2, 7.3, 7.4of text [1] below.

<u>Texts</u>

Text 1 - Edward B. Sa_, Arthur David Snider. Fundamentals of complex analysis with applications to engineering and science, 3rd Edition, Pearson Education India

<u>References</u>

1. John H Mathews, Russel W Howell. Complex Analysis for Mathematics and Engineering, 6th Edition, Jones and Bartlett Publishers
2. Murray R Spiegel. Complex variables: with an introduction to conformal mapping and its applications, Schaum's outline.
3. Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India
4. James Brown, Ruel Churchill. Complex Variables and Applications, Eighth Edition, McGraw-Hill

MM 1643 Abstract Algebra - Ring Theory

Instructional hours per week: 4 No.of credits: 3

Aim and objectives

After discussing the theory of groups thoroughly in the previous semester, we move towards the next higher algebraic structure rings. As in the last semester, all the new concepts appearing in the course is to be supported by numerous examples mainly from the references provided.

Module I (24 Hours)

- The concept of rings, sub rings with many examples should be discussed here. Next comes the definition and properties of integral domains, fields, and the characteristic of rings.
- Ideals, how factor rings are defined using ideals, should be explained next. The definition of prime and maximal ideals with examples should be discussed after that.

The topics to be discussed in this module can be found in chapter 12, 13 and 14 of text [1] below.

Module II (24 Hours)

- After introducing the definition of ring homomorphism, their properties should be discussed. The field of quotients of an integral domain should be discussed next. The next topic is the definition and various properties of polynomial rings over a commutative ring.

- Various results on operations on polynomials such as division algorithm, factor theorem, remainder theorem etc. should be discussed next. The definition and examples of PID's should be discussed next, before moving to the factorization of polynomials. Tests of irreducibility and reducibility and the unique factorization of polynomials over special rings should be discussed. .

The topics to be discussed in this module can be found in chapter 15, 16 and 17 of text [1] below.

Module III (24 Hours)

- In the last module, we introduce more rigorous topics like various type of integral domains. The divisibility properties of integral domains and definition of primes in a general ring should be introduced. Unique factorization domains and the Euclidean domains should be discussed next with examples. Results on these special integral domains are also to be discussed.

The topics to be discussed in this module can be found in chapter 18 of text [1] below.

Texts

Text 1-Joseph Gallian; Contemporary Abstract Algebra, 8th Edition, Cengage Learning

References

1. D S Dummit, R M Foote; Abstract Algebra, 3rd Edition, Wiley
2. I N Herstein, Topics in Algebra, Vikas Publications

MM 1644 Linear Algebra

Instructional hours per week: 5 No.of credits: 4

Aim and objectives

The main focus of this course is to introduce linear algebra and methods in it for solving practical problems.

Module I (15 Hours)

- This module deals with a study on linear equations and their geometry. After introducing the geometrical interpretation of linear equations, following topics should be discussed: various operations on column vectors, technique of Gaussian elimination, operations involving elementary matrices, interchanging of rows using elementary matrices, triangular factorization of matrices and finding inverse of matrices by the elimination method

.

The topics to be discussed in this module can be found in chapter 1 of text [1] below. The section 1.7 may be omitted

.

Module II (25 hours)

- Towards the study of vector spaces, specifically R^n, we define them with many examples. Subspaces are to be defined next. After discussing the idea of null space of a matrix. The solving linear equations (which was one to some extent in the first module) and finding solutions to non-homogeneous systems from the corresponding homogeneous systems. After this, linear independence and dependence of vectors, their spanning, basis for a space, its dimension concepts are to be introduced. The column, row, null, left null spaces of a matrix is to be discussed next. When inverses of a matrix exists related to its column/row rank should be discussed. Towards the end of this module, linear transformations (through matrices) and their properties are to be discussed. Types of transformations like rotations, projections, reflections are to be considered next.

The topics to be discussed in this module can be found in chapter 2 of text [1] below. The section 2.7 on graphs and networks may be omitted.

Module III (25 hours)

- This module is intended for making the idea and concepts of determinants stronger. Its properties like what happens when rows are interchanged, linearity of expansion along the first row, etc. are to be discussed. Breaking a matrix into triangular, diagonal forms and finding the determinants, expansion in cofactors, their applications like solving system of equations, finding volume etc. are to be discussed next.

The topics to be discussed in this module can be found in chapter 4 of text [1] below.

Module IV (25 hours)

- Here we conclude our analysis of matrices. The problem of finding Eigen values a matrix is to be introduced first. Next goal is to diagonalize a matrix. This concept should be discussed first, and move to the discussion on the use of Eigen vectors in diagonalization.
- Applications of finding the powers of matrices should be discussed next. The applications like the concept of Markov Matrices, Positive Matrices and their applications in Economics should be discussed. Complex matrices and operations on them are to be introduced next.
- The concept orthoganality of vectors may be required here from one of the previous sections in text [1] and it should be briefly introduced and discussed here. The module ends with similar matrices, and similarity transformation related ideas. How to diagonalize some special matrices like symmetric and Hermition matrices are also to be discussed in this module.

The topics to be discussed in this module can be found in chapter 5 of text [1] below. The section 5.4 on applications to differential equations may be omitted

Texts

Text 1-Gilbert Strang, Linear Algebra and Its Applications, 4th Edition, Cengage Learning

References

1. Video lectures of Gilber Strang Hosted by MITOpenCourseware available at https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/ Video-lectures/
2. Thomas Bancho_, John Wermer; Linear Algebra Through Geometry, 2nd Edition, Springer
3. T S Blyth, E F Robertson: Linear Algebra, Springer, Second Edition.
4. David C Lay: Linear Algebra, Pearson
5. K Hoffman and R Kunze: Linear Algebra, PHI

MM 1645 Integral Transforms

Instructional hours per week: 4 No.of credits: 3

Aim and objectives

After completing courses in ordinary differential equations and basic integral calculus, we see here some of its applications.

Module I (38 Hours)

- Laplace Transforms: Laplace Transform. Linearity. First Shifting Theorem (s-Shifting), Shifting: Replacing s by s□a in the Transform, Existence and Uniqueness of Laplace Transforms, Transforms of Derivatives and Integrals. ODEs, Laplace Transform of the Integral of a Function, Differential Equations, Initial Value Problems, Unit Step Function(Heaviside Function), Second Shifting Theorem (t□Shifting) Time Shifting (t□Shifting):
- Replacing t by t □ a in f (t), Short Impulses. Diracs Delta Function. Partial Fractions Convolution , Application to Non homogeneous Linear ODEs, Differentiation and Integration of Transforms, ODEs with Variable Coefficents, Integration of Transforms, Special Linear ODEs with Variable Coeffcients, Systems of ODEs

The topics to be discussed in this module can be found in sections 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7 of text [1] below.

Module II (34 hours)

- Fourier Series, Basic Examples, Derivation of the Euler Formulas, Convergence and Sum of a Fourier Series, Arbitrary Period. Even and Odd Functions. Half-Range Expansions From Period 2_ to any Period P = 2L, Simplifications: Even and Odd Functions, Half Range Expansions, Fourier Integral, From Fourier Series to Fourier Integral, Applications of Fourier Integrals, Fourier Cosine Integral and Fourier Sine Integral, Fourier Cosine and Sine Transforms, Linearity, Transforms of Derivatives, Fourier Transform, Complex Form of the Fourier Integral, Fourier Transform and Its Inverse, Linearity. Fourier Transform of Derivatives, Convolution.

The topics to be discussed in this module can be found in Sections 11.1, 11.2, 11.7, 11.8, 11.9 (Excluding Physical Interpretation: Spectrum and Discrete Fourier Transform(DFT),Fast Fourier Transform (FFT)) of text [1] below.

Texts

Text 1-Erwin Kreyszig. Advanced Engineering Mathematics, 10th Edition, Wiley-India

References

1. Ref. 1 { Peter V. O' Neil, Advanced Engineering Mathematics, Thompson Publications, 2007

MM 1661:1 Graph Theory (Elective)

Instructional hours per week: 3 No. of credits: 2

Aim and Objective:
The course has been designed to build an awareness of some of the fundamental concepts in Graph Theory and to develop better understanding of the subject so as to use these ideas skill fully in solving real world problems.

Module I (27 Hours)

- Basics : The Definition of a Graph, Graphs as Mathematical Models, other basic concepts and definitions, Vertex Degrees, Sub graphs, Paths and Cycles, The Matrix Representation of Graphs, Fusing graphs (The fusion algorithm for connectedness need not be discussed).
- Trees and Connectivity : Definitions and Simple Properties of trees, Bridges, Spanning Trees, Cut Vertices and Connectivity

The topics in this module can be found in Chapter1, Sections 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 and 1.8, Chapter 2, Sections 2.1, 2.2, 2.3 and 2.6 of text [1]

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Module II (27 Hours)

- Euler Tours and Hamiltonian Cycles : Euler Tours (Fleury's algorithm need not be discussed), The Chinese Postman Problem (Only Statement of the problem is to be discussed), Hamiltonian Graphs, The Travelling Salesman Problem (Only Statement of the problem is to be discussed, The Two-Optimal Algorithm and The Closest Insertion Algorithm need not be discussed)
- Planar Graphs : Plane and Planar Graphs, Euler's Formula, The Platonic Bodies, Kuratowski's Theorem (Without proof).

The topics in this module can be found in Chapter 3, Sections 3.1, 3.2, 3.3 and 3.4, Chapter 5, Sections 5.1, 5.2, 5.3 and 5.4 of text [1].

<u>Texts</u>

Text 1-John Clark, Derek Allan Holton. A _rst look at Graph Theory, World Scientific

<u>References</u>

1. R Balakrishnan, Ranganatahan. A Text Book of Graph Theory, 2nd Edition, Springer
2. V Balakrishnan. Graph Theory, Schaums Outline
3. J A Body, U S R Murthy. Graph Theory with Applications, The Macmillan Press

4. Robin J Wilson. Introduction to Graph Theory 5th edition, Prentice Hall