Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: B.Com.

Revised Syllabus of F.Y.B.Com. Mathematical & Statistical Techniques
Choice Based Credit & Grading System (75:25)
w.e.f. Academic Year 2019-20

Sr. No.	Heading	Particulars
1	Title of Course	Mathematical & Statistical Techniques
2	Eligibility for Admission	12^{th} Science & Commerce of all recognised Board
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (75:25)
8	Status	Revised
9	To be implemented from Academic year	2019-2020

F.Y.B.Com.

Introduction:

There is a rapid expansion of knowledge in subject matter areas and improved instructional method during last decade. There are considerable curricular revisions happening at the high school level. Applications of Mathematics and Statistics are widely used in industry and business. Keeping this in mind, a revision required in accordance with the growth of subject of at the high school level and emerging needs of industry and its application.

Objectives:

1. The main objective of this course is to introduce Mathematics and Statistics to undergraduate students of commerce, so that they can use them in the field of commerce and industry to solve the real life problems.
2. To familiarize students with the concept of Shares and Mutual Funds.
3. To familiarize students with the concept of permutation combinations, index number, time value of money, mathematical operations etc.
4. To understand the tools and techniques like measures of central tendencies, dispersion, Correlation and regression.
5. To equip the students with the ability to analysis Interpret data by using statistical techniques.
6. To motivate the students to apply statistical techniques for critical decision making and for research studies.
7. To enrich students for application of modern Statistical tools and techniques.

Learning Outcomes:

This course will help students to learn about the theoretical concept relating Mathematics and Statistics , Shares and Mutual Funds, Permutation Combinations, Index Number , Measures of central tendencies, Dispersion, Correlation and Regression, sources of data, classification of data, Probability, Probability Distribution etc. It will further help to apply the statistical tools and techniques for decision making and for research studies.

Teaching Pattern for Semester-I & II

1. Five lectures per week for course. Each lecture is of 48 minutes duration.
2. One tutorial (1L) per week per batch for course. (The batches to be formed as pre scribed by the University).

Scheme of Examination

Credit Based Evaluation System

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 25% marks in the first component by conducting the Semester End Examinations with 75% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

A) Internal Assessment: 25 **%** **25 Marks**

(For Courses without Practical)

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Questions to be set: 02
Duration: 40 Minutes
All Questions are Compulsory

Question No	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 75 % 75 Marks

- Duration: The examination shall be of $2\frac{1}{2}$ hour's duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 15 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

❖ **Passing Standard**

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 10 out of 25) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 30 Out of 75) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Revised Syllabus of Courses of B.Com. Programme at Semester I with Effect from the Academic Year 2019-2020

Core Courses (CC)

UCM1MST: Mathematical and Statistical Techniques I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
A) Mathematics: (30 Marks)		
1	Shares and Mutual Funds	15
2	Permutation, Combination and Linear Programming Problems	15
B) Statistics: (45 Marks)		
3	Summarization Measures	15
4	Elementary Probability Theory	15
5	Decision Theory	15
	Total	**75**

Note:

One tutorial per batch per week in addition to number of lectures stated above (Batch size as per the University norms)

Sr. No.	Modules / Units
A) Mathematics: (30 Marks)	
1	**Shares and Mutual Funds**
	• **Shares:** Concept of share, face value, market value, dividend, equity shares, preferential shares, bonus shares. Simple examples. • **Mutual Funds:** Simple problems on calculation of Net income after considering entry load, dividend, change in Net Asset Value (N.A.V.) and exit load. Averaging of price under the Systematic Investment Plan (S.I.P.)
2	**Permutation, Combination and Linear Programming Problems**
	• **Permutation and Combination:** Factorial Notation, Fundamental principle of counting, Permutation as arrangement, Simple examples, combination as selection, Simple examples, Relation between ${}^{n}C_{r}$ and ${}^{n}P_{r}$ Examples on commercial application of permutation and combination • **Linear Programming Problem:** Sketching of graphs of (i) linear equation Ax + By + C= 0 (ii) linear inequalities. Mathematical Formulation of Linear Programming Problems upto 3 variables. Solution of Linear Programming Problems using graphical method up to two variables.
B) Statistics: (45 Marks)	
3	**Summarization Measures**
	• **Measures of Central Tendencies:** Definition of Average, Types of Averages: Arithmetic Mean, Median, and Mode for grouped as well as ungrouped data. Quartiles, Deciles and Percentiles. Using Ogive locate median and Quartiles. Using Histogram locate mode. Combined and Weighted mean. • **Measures of Dispersions:** Concept and idea of dispersion. Various measures Range, Quartile Deviation, Mean Deviation, Standard Deviation, Variance, Combined Variance.
4	**Elementary Probability Theory**
	• **Probability Theory:** Concept of random experiment/trial and possible outcomes; Sample Space and Discrete Sample Space; Events their types, Algebra of Events, Mutually Exclusive and Exhaustive Events, Complimentary events. Classical definition of Probability, Addition theorem (without proof), conditional probability. Independence of Events: P(A ∩ B) = P(A) P(B). Simple examples. • **Random Variable:** Probability distribution of a discrete random variable; Expectation and Variance of random variable, simple examples on probability distributions.
5	**Decision Theory**
	Decision making situation, Decision maker, Courses of Action, States of Nature, Pay-off and Pay-off matrix; Decision making under uncertainty, Maximin, Maximax, Minimax regret and Laplace criteria; simple examples to find optimum decision. Formulation of Payoff Matrix. Decision making under Risk, Expected Monetary Value (EMV); Decision Tree; Simple Examples based on EMV. Expected Opportunity Loss (EOL), simple examples based on EOL.

Revised Syllabus of Courses of B.Com. Programme at Semester II with Effect from the Academic Year 2019-2020

Core Courses (CC)

UCM2MST: Mathematical and Statistical Techniques II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
A) Mathematics: (30 Marks)		
1	Functions, Derivatives and Their Applications	15
2	Interest and Annuity	15
B) Statistics: (45 Marks)		
3	Bivariate Linear Correlation and Regression	15
4	Time series and Index Numbers	15
5	Elementary Probability Distributions	15
	Total	**75**

Note:

One tutorial per batch per week in addition to number of lectures stated above (Batch size as per the University norms)

Sr. No.	Modules / Units
A) Mathematics: (30 Marks)	
1	**Functions, Derivatives and Their Applications**
	Concept of real functions: Constant function, linear function, x^n, e^x, a^x, log x. Demand, Supply, Total Revenue, Average Revenue, Total cost, Average cost and Profit function. Equilibrium Point, Break-even point. **Derivative of functions:** ▪ Derivative as rate measure, Derivative of x^n, e^x, a^x, log x. ▪ Rules of derivatives: Scalar multiplication, sum, difference, product, quotient (Statements only), Simple problems. Second order derivatives. ▪ Applications: Marginal Cost, Marginal Revenue, Elasticity of Demand. Maxima and Minima for functions in Economics and Commerce. (Examination Questions on this unit should be application oriented only.)
2	**Interest and Annuity**
	Interest: Simple Interest, Compound Interest (Nominal & Effective Rate of Interest), Calculations involving upto 4 time periods. **Annuity:** Annuity Immediate and its Present value, Future value. Equated Monthly Installments (EMI) using reducing balance method & amortization of loans. Stated Annual Rate & Affective Annual Rate Perpetuity and its present value. Simple problems involving up to 4 time periods.
B) Statistics: (45 Marks)	
3	**Bivariate Linear Correlation and Regression**
	Correlation Analysis: Meaning, Types of Correlation, Determination of Correlation: Scatter diagram, Karl Pearson's method of Correlation Coefficient (excluding Bivariate Frequency Distribution Table) and Spearman's Rank Correlation Coefficient. **Regression Analysis:** Meaning, Concept of Regression equations, Slope of the Regression Line and its interpretation. Regression Coefficients (excluding Bivariate Frequency Distribution Table), Relationship between Coefficient of Correlation and Regression Coefficients , Finding the equations of Regression lines by method of Least Squares.
Sr. No.	**Modules / Units**
4	**Time series and Index Numbers**
	Time series: Concepts and components of a time series. Representation of trend by Freehand Curve Method, Estimation of Trend using Moving Average Method and Least Squares Method (Linear Trend only). Estimation of Seasonal Component using Simple Arithmetic Mean for Additive Model only (For Trend free data only). Concept of Forecasting using Least Squares Method. **Index Numbers:** Concept and usage of Index numbers, Types of Index numbers, Aggregate and Relative Index Numbers, Lasperye's, Paasche's, Dorbisch-Bowley's, Marshall-Edgeworth and Fisher's ideal index numbers, Test of Consistency: Time Reversal Test and Factor Reversal Test. Chain Base Index Nos. Shifting of Base year. Cost of Living Index Numbers, Concept of Real Income, Concept of Wholesale Price Index Number. (Examples on missing values should not be taken)

5	**Elementary Probability Distributions**
	Probability Distributions: ▪ Discrete Probability Distribution: Binomial, Poisson (Properties and applications only, no derivations are expected) ▪ Continuous Probability distribution: Normal Distribution. (Properties and applications only, no derivations are expected)

Tutorial:

Two tutorials to be conducted on each unit i.e. 10 tutorials per semester. At the end of each semester one Tutorial assignment of 10 marks should be given.

Reference Books

Mathematical and Statistical Techniques

- *Mathematics for Economics and Finance Methods and Modelling by Martin Anthony and Norman Biggs, Cambridge University Press, Cambridge low-priced edition, 2000, Chapters 1, 2, 4, 6 to 9 & 10.*
- *Applied Calculus: By Stephen Waner and Steven Constenoble, Brooks/Cole Thomson Learning, second edition, Chapter 1 to 5.*
- *Business Mathematics By D. C. Sancheti and V. K. Kapoor, Sultan Chand & Sons, 2006, Chapter 1, 5, 7, 9 &10.*
- *Mathematics for Business Economics: By J. D. Gupta, P. K. Gupta and Man Mohan, Tata Mc- Graw Hill Publishing Co. Ltd., 1987, Chapters 9 to 11 & 16.*
- *Quantitative Methods-Part-I By S. Saha and S. Mukerji, New Central Book Agency, 1996, Chapters 7 & 12.*
- *Mathematical Basis of Life Insurance By S.P. Dixit, C.S. Modi and R.V. Joshi, Insurance Institute of India, Chapters 2: units 2.6, 2.9, 2.20 & 2.21.*
- *Securities Laws & Regulation of Financial Market : Intermediate Course Paper 8, Institute of Company Secretaries of India, Chapter 11.*
- *Investments By J.C. Francis & R.W. Taylor, Schaum's Outlines, Tata Mc-Graw Hill Edition 2000, Chapters 2,4 & section 25.1.*
- *Indian Mutual Funds Handbook : By Sundar Shankaran, Vision Books, 2006, Sections 1.7,1.8.1, 6.5 & Annexures 1.1to 1.3.*
- *STATISTICS by Schaum Series.*
- *Operations Research by Gupta and Kapoor*
- *Operations Research by Schaum Series*
- *Fundamentals of Statistics - D. N. Elhance.*
- *Statistical Methods - S.G. Gupta (S. Chand & Co.*
- *Statistics for Management - Lovin R. Rubin D.S. (Prentice Hall of India)*
- *Statistics - Theory, Method & Applications D.S.Sancheti & V. K. Kapoor.*
- *Modern Business Statistics - (Revised}-B. Pearles & C. Sullivan –Prentice Hall of India.*
- *Business Mathematics & Statistics: B Aggarwal, Ane Book Pvt. Limited*
- *Business Mathematics: D C Sancheti & V K Kapoor, Sultan Chand & Sons*
- *Business Mathematics: A P Verma, Asian Books Pvt. :Limited.*

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Program: B.Sc

Revised Syllabus of F.Y.B.Sc. Mathematics
Choice Based Credit & Grading System (75:25)
w.e.f. Academic Year 2019-20

Sr. No.	Heading	Particulars
1	Title of Course	Mathematics
2	Eligibility for Admission	12^{th} Science of all recognised Board
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (75:25)
8	Status	Revised
9	To be implemented from Academic year	2019-2020

F.Y.B.Sc.

Introduction:

Mathematics pervades all aspects of life, whether at home, in civic life or in the workplace. It has been central to nearly all major scientific and technological advances. Many of the developments and decisions made in our community rely to an extent on the use of mathematics. Besides foundation skills and knowledge in mathematics for all citizen in the society, it is important to widen mathematical experience for those who are mathematically inclined.

Aims and Objectives:

1. Giving students sufficient knowledge of fundamental principles, methods and a clear perception of boundless power of mathematical ideas and tools and know how to use them by analysing, modeling, solving and interpreting.

2. Reflecting on the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science

3. Enhancing students overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment

4. A student should get adequate exposure to global and local concerns by looking at many aspects of mathematical Sciences

Outcomes:

1. Students Knowledge and skills will get enhanced and they will get confidence and interest in mathematics, so that they can master mathematics effectively and will be able to formulate and solve problems from mathematical perspective.

2. Students thinking ability and attitude will change towards learning mathematics and practicals will improve their logical and analytical thinking.

Teaching Pattern for Semester-I

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for practical USMTP01 (the batches to be formed as pre scribed by the University).

Teaching Pattern for Semester-II

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for practical USMTP02 (the batches to be formed as pre scribed by the University).

Scheme of Examination
Faculty of Science
(Undergraduate Programmes)

Credit Based Evaluation System

The performance of the learners shall be evaluated into two components. The learners Performance shall be assessed by Internal Assessment with 25% marks in the first component by conducting the Semester End Examinations with 75% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

(A) Internal Assessment: 25% (25 Marks)

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Questions to be set: 02
Duration: 40 Minutes
All Questions are Compulsory

Sr. No.	Particular	Marks
Q-01	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-02	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

(B) Semester End Examination: 75% (75 Marks)

Duration: The examination shall be of $2\frac{1}{2}$ hours duration.

Question Paper Pattern

Sr. No.	Particular
1	There shall be four questions.
2	On each unit there will be one question and fourth question will be based on entire syllabus.
3	Question number 1, 2 and 3 will be of 20 marks each (40 marks with internal options) and question number 4 will be of 15 marks (30 marks with internal options).
4	All questions shall be compulsory with internal options.
5	Question may be subdivided into sub-questions $a, b, c, \cdots$ and the allocation of marks depends on the weightage of the unit.

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 10 out of 25) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 30 Out of 75) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Semester End Practical Examinations

At the end of the Semesters I & II Practical examinations of two hours duration and100 marks shall be conducted for the courses USC1MT1,USC1MT2

In semester I, the Practical examinations for USC1MT1 and USC1MT2 are held together.

In Semester II, the Practical examinations for USC2MT1 and USC2MT2 are held together.

Paper Pattern

There will be Two Sections Section I & Section II for Mathematics Practical Question paper USC1MTP/USC2MTP

Section-I: Based on USC1MT1/USC2MT1

Section-II: Based on USC1MT2/USC2MT2

Maximum Marks: 80

Duration: 02 Hours

Section I

Q.1: Objective Questions- Attempt any 8 out of 12 multiple choice questions.$(8 \times 3 = 24)$

Q.2 : Problems- Attempt any two out of Three. $(8 \times 2 = 16)$

Section II

Q.1: Objective Questions- Attempt any 8 out of 12 multiple choice questions.$(8 \times 3 = 24)$

Q.2 : Problems- Attempt any two out of Three. $(8 \times 2 = 16)$

Marks for Journals and Viva:

For each course USC1MT1, USC1MT2 and USC2MT1, USC2MT2

1. Journals: 05 marks.
2. Viva:05 marks.

List of Courses for Semester-I

CALCULUS-I

Cource Code	Unit	Topic	Credit	Lecture per Week
USC1MT1	Unit I	Real Number System	2	3
	Unit II	Sequences		
	Unit III	Differential Equations		

ALGEBRA-I

Cource Code	Unit	Topic	Credit	Lecture per Week
USC1MT2	Unit I	Sets and functions	2	3
	Unit II	Integers and divisibility		
	Unit III	Theory of congruences		

PRACTICAL-I

Cource Code	Unit	Topic	Credit	Lecture per Week
USC1MTP	Section- I	USC1MT1	2	2
	Section II	USC1MT2		

List of Courses for Semester-II

CALCULUS-II

Cource Code	Unit	Topic	Credit	Lecture per Week
USC2MT1	Unit I	Limits and Continuity	2	3
	Unit II	Continuous functions and Differentiation		
	Unit III	Applications of differentiation		

ALGEBRA-II

Cource Code	Unit	Topic	Credit	Lecture per Week
USC2MT2	Unit I	System of Linear Equations and Matrices	2	3
	Unit II	Permutations		
	Unit III	Polynomials		

PRACTICAL-II

Cource Code	Unit	Topic	Credit	Lecture per Week
USC2MTP	Section- I	USC2MT1	2	2
	Section II	USC2MT2		

Syllabus for Semester-I

USC1MT1: CALCULUS I

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

Course Description:
We begin with a brief introduction of real numbers which will enable students to understand properties of real numbers.We will introduce real numbers and properties which will help students to understand the origin of number system. Basic theorems of real analysis like Archimedean property, Hausdorff property with applications will be introduced. After this we start with sequence of real numbers and concept of convergent sequences that will help students understand and solve problems which are widely prevalent in all branches of science. We introduced differential equation in next unit which has variety of applications in real world.

Unit I : Real Number System (15 Lectures)

1. Real number system $\mathbb{R}$ and order properties of $\mathbb{R}$, absolute value $||$ and its properties.

2. AM-GM inequality, Cauchy-Schwarz inequality, Intervals and neighbourhoods, Hausdorff property.

3. Bounded sets, statements of l.u.b. axiom and its consequences, Supremum and Infimum, Maximum and Minimum, Archimedean property and its applications, density of rationals.

Unit II : Sequences (15 Lectures)

1. Definition of a sequence and examples, Convergence of sequences, every convergent sequences is bounded. Limit of a convergent sequence and uniqueness of limit, Divergent sequences.

2. Convergence of standard sequences like (i) $\frac{1}{1+na}$ where $a > 0$, (ii) b^n where $0 < b \leq 1$, (iii) $c^{\frac{1}{n}}$ where $c > 0$, (iv) $n^{\frac{1}{n}}$

3. Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem and consequences as convergence of $\left(1 + \frac{1}{n}\right)^n$

4. Definition of subsequence, subsequence of a convergent sequence is convergent and converges to the same limit, definition of a Cauchy sequences, every convergent sequences s a Cauchy sequence and converse

Unit III :Differential Equations (15 Lectures)

1. Solutions of homogeneous and non-homogeneous differential equations of first order and first degree, Notion of partial derivative, solving exact differential equations.

2. Rules for finding integrating factor (I.F) (without proof) for non-exact equations such as:

(a) $\frac{1}{Mx+Ny}$ is an I.F if $Mx + Ny \neq 0$ and $Mdx + Ndy$ is homogeneous

(b) $\frac{1}{Mx-Ny}$ is an I.F if $Mx - Ny \neq 0$ and $Mdx + Ndy$ is of the type $f_1(xy)ydx + f_2(xy)xdy = 0$

(c) $e^{\int f(x)dx}$ is an I.F if $N \neq 0$ and $\frac{1}{N}\left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x}\right)$ is a function of x alone say $f(x)$

(d) $e^{\int g(y)dy}$ is an I.F if $M \neq 0$ and $\frac{1}{M}\left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right)$ is a function of y alone say $g(y)$

3. Finding solutions of first order differential equations of the type $\frac{dy}{dx} + P(x)y = Q(x)y^n$ for $n \geq 0$. Applications to orthogonal trajectories, population growth, and finding the current at a given time.

Refference Books

1. K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
2. R.R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
3. G. F. Simmons, Differential equations with applications and historical notes, Mc-Graw Hill.
4. E. A. Coddington, An introduction to ordinary differential equations, Dover Books.
5. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.

Additional Refference Books

1. T.M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pte, Ltd.
2. Richard Courant-Fritz John, A Introduction to Calculus and Analysis, Volume I, Springer.
3. Ajit kumar- S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
4. James Stewart, Calculus, Third Edition, Brooks cole Publishing Company, 1994.
5. Ghorpade, Sudhir R.-Limaye, Balmohan V., A Course and Real Analysis, Springer International Ltd.2000.

USC1MT2: ALGEBRA I

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

Course Description:
The aim of this course is to introduce students to basic concepts like sets, relations, equivalence relations and functions, etc. It will make students learn different techniques of proving theorems, lemmas using induction, proof by contradiction etc. We also equip them with integers, division algorithm, congruences and its applications.

Unit I : Sets and functions (15 Lectures)

1. Negation of a statement, use of quantifiers, sets, union and intersection of sets, complement of a set, De Morgans law, Cartesian product of sets.

2. Definition of a function; domain, co-domain and range of a function, composite functions, examples, Graph of a function, Injective, surjective, bijective functions; composite of injective, surjective, bijective functions when defined.

3. Invertible functions, bijective functions are invertible and conversely. Examples of functions including constant, identity, projection, inclusion.

4. Image and inverse image of a set under f interrelated with union, intersection and complement. Finite and infinite sets. Countable set and its examples such as $\mathbb{Z}, \mathbb{Q}$. Uncountable set and its examples.

Unit II : Integers and divisibility (15 Lectures)

1. Well-ordering property, First and second principle of mathematical induction as a consequence of well-ordering property

2. Divisibility in integers, division algorithm, existence & uniqueness of greatest common divisor(g.c.d.) and least common multiple (l.c.m.) and their basic properties. Bezouts identity and its applications.

3. Euclidean algorithm, Primes, Euclids lemma, Fundamental theorem of arithmetic, The set of primes is infinite.

4. The necessary and sufficient condition to have a solution for the linear Diophantine equation ax + by = c. Solving of linear Diophantine equation with examples.

Unit III :Theory of congruences (15 Lectures)

1. Equivalence relation, equivalence classes and properties, Definition of a partition, every partition gives an equivalence relation and vice versa. Congruences, definition and elementary properties, Congruence is an equivalence relation on $\mathbb{Z}$, residue classes and partition of $\mathbb{Z}$, addition modulo n, multiplication modulo n, examples

2. Linear congruences. Chinese remainder theorem and its applications

3. Eulers ϕ function, Eulers theorem, Fermats little theorem, Wilsons theorem and their applications.

Refference Books

1. David M. Burton, Elementary Number Theory, Seventh Edition, McGraw Hill Education (India) Private Ltd.
2. S. Kumaresan, Ajit Kumar and Bhaba Kumar Sarma, A foundation course in Mathematics, 2018 edition, Narosa publication house.
3. David M. Burton, Elementary number theory, seventh edition, Tata McGraw-Hill edition.

Additional Refference Books

1. Ivan Niven, Herbert S. Zuckerman, Introduction to the theory of numbers, fifth edition, Wiley eastern limited.
2. R.G. Bartle and D.R. Sherbert, Introduction to real analysis, third edition, John Wiley and Sons.
3. Jones and Jones, Elementary number theory, second edition, Springer
4. I.S. Luthar, Sets, functions and numbers, 2005 edition, Narosa publishing house.
5. Thomas Koshy, Elementary number theory with applications, Academic press

USC1MTP: MATHEMATICS PRACTICAL-I

(A) **Practicals for USC1MT1**

(I) Application based examples of Archimedean property, intervals, nieghbourhood. Consequences of l.u.b axiom, infimum and supremum of sets.

(II) Problems on convergent sequences,subsequences and Cauchy sequences

(III) Solving exact, non- exact and Bernoullis differential equations.

(IV) Miscellaneous Theoretical Questions based on full paper.

(B) **Practicals for USC1MT2**

(I) Problems on countability,Functions(image and inverse image), injective, surjective, bijective functions, finding inverses of bijective functions.

(II) Problems on Mathematical induction, Division Algorithm and Euclidean algorithm in $\mathbb{Z}$, undamental theorem of arithmetic and solving linear Diophantine equations.

(III) Problems on congruences, equivalence relation and Chinese remainder theorem,Eulers function, Fermats little theorem, Wilsons theorem.

(IV) Miscellaneous Theoretical Questions based on full paper.

Syllabus for Semester-II

USC2MT1: CALCULUS II

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

Course Description: The aim of this course is to expose students to the beauty of limits, continuity and the concept of differentiation. The first unit is based on limits and continuity in which students learn the definition of continuity and sequential continuity and the equivalence between them. Problems based on these concepts are solved rigourously. The next unit is based on continuty and differentiability. Here students understand the notion of differentiation of a real valued function and mean value theorems. In the last section the emphasis is on applications of differentiability.

Unit I : Limits and Continuity (15 Lectures)
Brief review: Domain and range of a function, injective function, surjectiove function, bijective function, composite of two functions, (when defined) Inverse of a bijective function

1. Graphs of same standard functions such as $\mid x \mid, e^x, logx, ax^2 + bx + c, \frac{1}{x}, x^n (n \geq 3), \sin x, \cos x, \tan x, \sin \frac{1}{x}, x^2 \sin \frac{1}{x}$ over suitable intervals of $\mathbb{R}$

2. Definition of Limit of a function $\lim_{x \to a} f(x)$,evaluation of limit of simple functions using the $\epsilon - \delta$ definition, uniqueness of limit if it exists, algebra of limits, limits of composite function, sandwich theorem, left-hand-limit $\lim_{x \to a^-} f(x)$, Right hand-limit $\lim_{x \to a^+} f(x)$

3. Continuous functions: Continuity of a real valued function on a set in terms of limits, examples, Continuity of a real valued function at end points of domain, Sequential continuity, Algebra of continuous functions, discontinuous functions, examples of removable and essential discontinuity.

Unit II : Continuous Functions and Differentiability (15 Lectures)

1. If $f : [a, b] \to \mathbb{R}$ is continuous at $x_0 \in [a, b]$ and $f(x_0) > 0$ then there exists a neighbourhood N of x_0 such that $f(x) > 0 \ \forall x \in N$, If $f : [a, b] \to \mathbb{R}$ is continuous function then the image $f([a, b])$ is a closed interval, Intermediate value theorem and its applications, Bolzano- Weierstrass theorem (statement only): A continuous function on a closed and bounded interval is bounded and attains its bounds.

2. Differentiation of real valued function of one variable: Definition of differentiation at a point of an open interval, examples of differentiable and non differentiable functions, differentiable functions are continuous but not conversely, chain rule , Higher order derivatives, Leibnitz rule, Derivative of inverse functions, Implicit differentiation (only examples)

Unit III : Applications of differentiation (15 Lectures)

1. Definition of local maximum and local minimum, necessary condition, stationary points, second derivative test, examples, Graphing of functions using first and second derivatives, concave , convex , concave functions, points of inflection

2. Rolles theorem, Lagranges and Cauchys mean value theorems, applications and examples, Monotone increasing and decreasing function, examples,

3. L-Hospital rule without proof, examples of intermediate forms, Taylors theorem with Lagranges form of remainder with proof. Taylors polynomial and applications.

Refference Books

1. R.R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.

2. James Stewart, Calculus, Third Edition, Brooks Cole Publishing company, 1994.

3. T.M.Apostol, Calculus, Vol I, Wiley And Sons (Asia) Pte. Ltd.

Additional Refference Books

1. Richard Courant- Fritz John, A Introduction to Calculus and Analysis, Volume-I, Springer.

2. Ajit Kumar- S.Kumaresan, A Basic course in Real Analysis, CRC Press, 2014.

3. Ghorpade, Sudhir R, -Limaye, Balmohan V, A course in Calculus and Real Analysis, Springer International Ltd, 2000.

4. K.G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.

5. G.B.Thomas, Calculus, 12 th Edition 2009

USC2MT2: ALGEBRA II

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

Course Description:
The aim of this course is to introduce System of linear equations and matrices and to understand polynomials over R and permutations of a set. The first unit is devoted to system of linear equations.The second unit is devoted to permutation.In this unit we introduce symmetries of triangle, rectangle and squares. We also introduced cycle and transposition in second unit. In the last unit we introduce polynomials over set of reals and complex numbers.We also introduce gcd of two polynomials over R, Euclidean algorithm and solve problems based on that. Different techniques using rational root theorem will enable students to find roots of a polynomial.

Unit I :System of Equations and Matrices (15 Lectures)

1. Parametric Equation of Lines and Planes , System of homogeneous and non homogeneous linear Equations, The solution of m homogeneous linear equations in n unknowns by elimination and their geometrical interpretation for $(m, n) = (1, 2), (1, 3), (2, 2), (2, 2), (3, 3)$; Definition of n-tuple of real numbers, sum of n-tuples and scalar multiple of n-tuple. Deduce that the system of m homogeneous linear equations has a non trivial solution if $m < n$.

2. Matrices with real entries; addition, scalar multiplication of matrices and multiplication of matrices, transpose of a matrix, types of matrices: zero matrix, identity matrix, scalar matrix, diagonal matrix, upper and lower triangular matrices, symmetric matrix, skew symmetric matrix, invertible matrix; Identities such as $(AB)^t = B^tA^t$, $(AB)^{-1} = B^{-1}A^{-1}$

3. System of linear equations in matrix form , Elemetary row operations , row echelon matrix, Gausian elimination method, Gauss Seidal Method.

Unit II : Permutations (15 Lectures)

1. Definition of a permutation of a set, Set of all permutations of the set $\{1, 2, \cdots, n\}$ i.e. S_n and its cardinality, Symmetries of an equilateral triangle, square, rectangle.

2. Cycles, Composition of permutations, properties of permutations such as every permutation of a finite set can be written as a cycle or a product of disjoint cycles, disjoint cycles commute.

3. Transpositions, Any permutation can be expressed as a product of transpositions, order of a permutation, sign of a permutation.

Unit III : Polynomials (15 Lectures)

1. Definition of a polynomial, polynomials over the $\mathbb{Q}$,$\mathbb{R}$ or $\mathbb{C}$, Algebra of polynomials, degree of polynomial, basic properties.

2. Division algorithm in $\mathbb{R}[x]$ (without proof), and g.c.d of two polynomials and its basic properties (without proof), Euclidean algorithm (without proof),applications, Roots of a polynomial, relation between roots and coefficients,multiplicity of a root, Remainder theorem, Factor theorem

3. A polynomial of degree n has at most n roots, Complex roots of a polynomial in $\mathbb{R}[x]$ occur in conjugate pairs, Statement of Fundamental Theorem of Algebra, A polynomial of degree n in$\mathbb{C}[x]$ has exactly n complex roots counted with multiplicity, A non constant polynomial in $\mathbb{R}[x]$ can be expressed as a product of linear and quadratic factors in $\mathbb{R}[x]$, necessary condition for a rational number $\frac{p}{q}$ to be a root a polynomial with integer coefficients, simple consequences such as is a irrational number $\sqrt{p}$ where is p a prime number, n^{th} roots of unity, sum of all the n^{th} roots of unity.

Refference Books

1. S. Kumaresan, Linear algebra, a geometric approach first edition, Prentice hall of India, 2009.

2. Joseph A. Gallian, Contemporary abstract algebra, fourth edition, Narosa publications.

3. John Fraleigh, A first course in abstract algebra, seventh edition, Pearson, 2013.

Additional Refference Books

1. Norman L. Biggs, Discrete mathematics, second edition, Oxford university press.

2. I.N. Herstein, Topics in algebra, second edition, Wiley India edition.

3. Serge Lang, Introduction to linear algebra, second edition, Springer.

USC2MTP: MATHEMATICS PRACTICAL-II

(A) **Practicals for USC2MT1**

(I) Calculating limts of sequences, Cauchy sequences, monotone sequences.

(II) Limits of function and Sandwich theorem, continuous and discontinuous functions,Properties of continuous and differentiable functions. Higher order derivatives, Leibnitz theorem. Mean value theorems and its applications

(III) Extreme values, increasing and decreasing functions. Applications of Taylors theorem and Taylors polynomials.

(IV) Miscellaneous Theoretical Questions based on full paper

(B) **Practicals for USC2MT2**

(I) Solving homogeneous system of m equations in n unknowns by elimination for $(m, n) = (1, 2), (1, 3), (2, 2), 2, 3), (3, 3)$,row echelon form. Solving system $Ax = B$ by Gauss elimination, Solutions of system of linear Equations.

(II) permutations of a finite set, Symmetries, cycles, compositions of permutations,Permutation as a product of 2-cycles, order and sign of a permutation.

(III) Problems on division algorithm and gcd of two polynomials,Problems based on factor theorem, remainder theorem and rational root theorem.

(IV) Miscellaneous Theoretical Questions based on full paper

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: B.Sc.

Revised Syllabus of S.Y.B.Sc. Mathematics
Choice Based Credit & Grading System (75:25)
w.e.f. Academic Year 2020-21

JANARDAN BHAGAT SHIKSHAN PRASARAK SANSTHA'S

CHANGU KANA THAKUR

ART'S, COMMERCE AND SCIENCE COLLEGE, NEW PANVEL

AUTONOMOUS

BOARD OF STUDIES IN MATHEMATICS

MATHEMATICS

FROM THE ACADEMIC YEAR

2020-2021

S.Y.B.Sc.

Introduction:

Mathematics pervades all aspects of life, whether at home, in civic life or in the workplace. It has been central to nearly all major scientific and technological advances. Many of the developments and decisions made in our community rely to an extent on the use of mathematics. Besides foundation skills and knowledge in mathematics for all citizen in the society, it is important to widen mathematical experience for those who are mathematically inclined.

Aims and Objectives:

1. Giving students sufficient knowledge of fundamental principles, methods and a clear perception of boundless power of mathematical ideas and tools and know how to use them by analysing, modeling, solving and interpreting.
2. Reflecting on the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science
3. Enhancing students overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment
4. A student should get adequate exposure to global and local concerns by looking at many aspects of mathematical Sciences

Outcomes:

1. Students knowledge and skills will get enhanced and they will get confidence and interest in mathematics, so that they can master mathematics effectively and will be able to formulate and solve problems from mathematical perspective.
2. Students thinking ability and attitude will change towards learning mathematics and practicals will improve their logical and analytical thinking.

Teaching Pattern for Semester-III

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for courses USC3MT1, USC3MT2 combined and one Practical (3L) per week for course USC3MT3 (the batches to be formed as prescribed by the University). Each practical session is of 48 minutes duration.

Teaching Pattern for Semester-IV

1. Three lectures per week per course. Each lecture is of 48 minutes duration.
2. One Practical (2L) per week per batch for courses USC3MT1, USC3MT2 combined and one Practical (3L) per week for course USC3MT3 (the batches to be formed as prescribed by the University). Each practical session is of 48 minutes duration.

Scheme of Examination
Faculty of Science
(Undergraduate Programmes)

Credit Based Evaluation System

The performance of the learners shall be evaluated into two components. The learners Performance shall be assessed by Internal Assessment with 25% marks in the first component by conducting the Semester End Examinations with 75% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

(A) Internal Assessment: 25% (25 Marks)

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern

(Periodical Class Test for the Courses at Under Graduate Programmes)

Maximum Marks: 20
Questions to be set: 02
Duration: 40 Minutes
All Questions are Compulsory

Sr. No.	Particular	Marks
Q-01	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-02	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

(B) Semester End Examination: 75% (75 Marks)

Duration: The examination shall be of $2\frac{1}{2}$ hours duration.

Question Paper Pattern

Sr. No.	Particular
1	There shall be four questions.
2	On each unit there will be one question and fourth question will be based on entire syllabus.
3	Question number 1, 2 and 3 will be of 20 marks each (40 marks with internal options) and question number 4 will be of 15 marks (30 marks with internal options).
4	All questions shall be compulsory with internal options.
5	Question may be subdivided into sub-questions $a, b, c, \cdots$ and the allocation of marks depends on the weightage of the unit.

Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 10 out of 25) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 30 Out of 75) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Semester End Practical Examinations

At the end of the Semesters III & IV, Practical examinations of three hours duration and 150 marks shall be conducted for the courses USC3MTP, USC4MTP.

In semester III, the Practical examinations for USC3MT1 and USC3MT2 are held together by the college. The Practical examination for USC3MT3 is held separately by the college.

In semester IV, the Practical examinations for USC4MT1 and USC4MT2 are held together by the college. The Practical examination for USC4MT3 is held separately by the college.

Paper Pattern

The question paper shall have three parts A,B, C.

Each part shall have two Sections.

Section I: Objective in nature: Attempt any Eight out of Twelve multiple choice questions. $(8 \times 3 = 24$ Marks)
Section II: Problems: Attempt any Two out of Three. $(8 \times 2 = 16$ Marks)

Practical Course	Part A	Part B	Part C	Marks out of	Duration
USC3MTP	Questions from USC3MT1	Questions from USC3MT2	Questions from USC3MT3	120	3
USC4MTP	Questions from USC4MT1	Questions from USC4MT2	Questions from USC4MT3	120	3

Marks for Journals and Viva:

For each course USC3MT1, USC3MT2,USC3MT3 and USC4MT1, USC4MT2,USC4MT3

1. Journals: 05 marks.
2. Viva:05 marks.

List of Courses for Semester-III

PAPER I: CALCULUS-III

Cource Code	Unit	Topic	Credit	Lecture per Week
USC3MT1	Unit I	Functions of several variables	2	3
	Unit II	Differentiation		
	Unit III	Applications		

PAPER II: ALGEBRA-III

Cource Code	Unit	Topic	Credit	Lecture per Week
USC3MT2	Unit I	Vector spaces over $\mathbb{R}$	2	3
	Unit II	Linear Transformations and Matrices		
	Unit III	Determinants		

PAPER III: DISCRETE MATHEMATICS

Cource Code	Unit	Topic	Credit	Lecture per Week
USC3MT3	Unit I	Graphs	2	3
	Unit II	Preliminary Counting		
	Unit III	Advanced Counting		

PRACTICAL-III

Cource Code	Part	Paper	Credit	Lecture per Week
USC3MTP	A	USC3MTP	3	5
	B	USC3MT2		
	C	USC3MT3		

List of Courses for Semester-IV

PAPER I: CALCULUS-IV

Cource Code	Unit	Topic	Credit	Lecture per Week
USC4MT1	Unit I	Riemann Integration	2	3
	Unit II	Indefinite Integrals and Improper Integrals		
	Unit III	Applications		

PAPER II: ALGEBRA-IV

Cource Code	Unit	Topic	Credit	Lecture per Week
USC4MT2	Unit I	Inner Product Spaces	2	3
	Unit II	Eigenvalues and Eigenvectors		
	Unit III	Diagonalization		

PAPER III: ORDINARY DIFFERENTIAL EQUATIONS

Cource Code	Unit	Topic	Credit	Lecture per Week
USC4MT3	Unit I	Second order differential equations	2	3
	Unit II	Power Series solution of ordinary differential equations		
	Unit III	Laplace Transform		

PRACTICAL-IV

Cource Code	Part	Paper	Credit	Lecture per Week
USC4MTP	A	USC4MT1	3	5
	B	USC4MT2		
	C	USC4MT3		

Syllabus for Semester-III

USC3MT1: CALCULUS-III

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

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1. **Unit I: Functions of several variables** **(15 Lectures)**

   (a) The Euclidean inner product on $\mathbb{R}^n$ and Euclidean norm function on $\mathbb{R}^n$, distance between two points, open ball in $\mathbb{R}^n$, definition of an open subset of $\mathbb{R}^n$, neighborhood of a point in $\mathbb{R}^n$, sequences in $\mathbb{R}^n$, convergence of sequences- these concepts should be specically discussed for n = 2 and n = 3.

   (b) Functions from $\mathbb{R}^n \to \mathbb{R}$ (scalar fields) and from $\mathbb{R}^n \to \mathbb{R}^m$ (vector fields), limits, continuity of functions, basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity and components of a vector fields.

   (c) Directional derivatives and partial derivatives of scalar fields.

   (d) Mean value theorem for derivatives of scalar fields.

---

2. **Unit II: Differentiation** **(15 Lectures)**

   (a) Differentiability of a scalar field at a point of $\mathbb{R}^n$ (in terms of linear transformation) and on an open subset of $\mathbb{R}^n$, the total derivative, uniqueness of total derivative of a differentiable function at a point, simple examples of finding total derivative of functions such as $f(x, y) = x^2 + y^2$, $f(x, y, z) = x + y + z$, differentiability at a point of a function f implies continuity and existence of direction derivatives of f at the point, the existence of continuous partial derivatives in a neighborhood of a point implies differentiability at the point.

   (b) Gradient of a scalar field, geometric properties of gradient, level sets and tangent planes.

   (c) Chain rule for scalar fields.

   (d) Second order partial derivatives, mixed partial derivatives, sucient condition for equality of mixed partial derivative.

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3. **Unit III: Applications** **(15 lectures)**

   (a) Second order Taylors formula for scalar fields.

   (b) Differentiability of vector fields, denition of differentiability of a vector field at a point, Jacobian matrix, differentiability of a vector field at a point implies continuity. The chain rule for derivative of vector fields (statements only)

   (c) Mean value inequality.

   (d) Hessian matrix, Maxima, minima and saddle points.

   (e) Second derivative test for extrema of functions of two variables.

   (f) Method of Lagrange Multipliers.

Recommended Text Books:

1. T. Apostol: Calculus, Vol. 2, John Wiley.
2. J. Stewart, Calculus, Brooke/ Cole Publishing Co.

Additional Reference Books

1. G.B. Thoman and R. L. Finney, Calculus and Analytic Geometry, Ninth Edition, Addison-Wesley, 1998.
2. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Multivariable Calculus and Analysis, Springer International Edition.
3. Howard Anton, Calculus- A new Horizon, Sixth Edition, John Wiley and Sons Inc, 1999.

Suggested Practicals (Sem III)

1. Sequences in $\mathbb{R}^2$ and $\mathbb{R}^3$ limits and continuity of scalar fields and vector fields ,using definition and otherwise, iterated limits.
2. Computing directional derivatives, partial derivatives and mean value theorem of scalar fields.
3. Total derivative, gradient, level sets and tangent planes.
4. Chain rule, higher order derivatives and mixed partial derivatives of scalar fields.
5. Taylors formula, differentiation of a vector field at a point, nding Hessian/Jacobean matrix, Mean Value Inequality.
6. Finding maxima, minima and saddle points, second derivative test for extrema of functions of two variables and method of Lagrange multipliers.
7. Miscellaneous Theoretical Questions based on full paper

USC3MT2: ALGEBRA-III
(LINEAR ALGEBRA-I)

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

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1. **Unit I: Vector Spaces over $\mathbb{R}$** **(15 Lectures)**

   (a) Definition of a Vector Spaces over $\mathbb{R}$ and examples.

   (b) Subspaces - definition and examples.

   (c) The sum and intersection of subspaces, direct sum of vector spaces.

   (d) Linear combination of vectors, convex sets, linear span of a subset of a vector space.

   (e) Linear dependence and independence of a set.

   (f) Basis of a vector space, basis as a maximal linearly independent set and a minimal set of generators. Dimension of a vector space.

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2. **Unit II: Linear Transforations and Matrices** **(15 Lectures)**

   (a) Linear transformations: definition, properties and examples, Kernel and image of a linear transformation, Rank-Nullity theorem (with proof), Linear isomorphisms, inverse of a linear isomorphism, Matrix and linear transformation.

   (b) The matrix units and elementary matrices.

   (c) Row space, column space of an $m \times n$ matrix, row rank and column rank of a matrix.

   (d) Equivalence of rank of an $m \times n$matrix A and rank of the linear transformation $L_A : \mathbb{R}^n \to \mathbb{R}^m (L_A(A) = AX)$.The dimension of solution space of the system of linear equations $AX = 0$ equals n rank (A).

   (e) The solutions of non-homogeneous systems of linear equations represented by $AX = B$ and the general solution of the homogeneous system.

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3. **Unit III: Determinants** **(15 Lectures)**

   (a) Definition of determinant as an n-linear skew-symmetric function. Determinant of a matrix as determinant of its column vectors (or row vectors).

   (b) Existence and uniqueness of determinant function via permutations.

   (c) Laplace expansion of a determinant, Vandermonde determinant, determinant of upper triangular and lower triangular matrices.

   (d) Linear dependence and independence of vectors in $\mathbb{R}^n$ using determinants, The existence and uniqueness of the system $AX = B$, where A is an $n \times n$matrix with $det(A) \neq 0$.

(e) Cofactors and minors of a matrix, Adjoint of an $n \times n$ matrix A.

(f) Cramer's rule.

(g) Determinant as area and volume.

Recommended Books:

1. Serge Lang: Introduction to Linear Algebra, Springer Verlag.
2. S. Kumaresan: Linear Algebra A geometric approach, Prentice Hall of India Private Limited.

Additional Reference Books:

1. M. Artin: Algebra, Prentice Hall of India Private Limited.
2. K. Hoffman and R. Kunze: Linear Algebra, Tata McGraw-Hill, New Delhi.
3. Gilbert Strang: Linear Algebra and its applications, International Student Edition.
4. L. Smith: Linear Algebra, Springer Verlag.
5. A. Ramachandra Rao and P. Bhima Sankaran: Linear Algebra, Tata McGrawHill, New Delhi.
6. T. Banchoff and J. Wermer: Linear Algebra through Geometry, Springer Verlag Newyork, 198
7. Sheldon Axler : Linear Algebra done right, Springer Verlag, Newyork.
8. Klaus Janich : Linear Algebra.
9. Otto Bretcher: Linear Algebra with Applications, Pearson Education.
10. Gareth Williams: Linear Algebra with Applications, Narosa Publication.

Suggested Practicals (Sem III)

1. Subspaces: Determine whether a given subset of a vector space is a subspace.
2. Linear dependence and independence of subsets of a vector space.
3. Rank-Nullity Theorem.
4. System of linear equations.
5. Determinant, calculating determinants of 2×2 matrices, $n \times n$ diagonal, upper triangular matrices using definition and laplace exapansion.
6. Finding inverses of Finding inverses of $n \times n$ matrices using adjoint
7. Determinant, calculating determinants of 2×2 matrices, 3×3 matrices using adjoint.
8. Miscellaneous Theoretical Questions based on full paper

USC3MT3: DISCRETE MATHEMATICS

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

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1. **Unit I: Graphs** **(15 Lectures)**

   (a) Introduction to graphs: Types of graphs: Simple graph, directed graph, (One example/graph model of each type to be discussed).

   (b) Graph Terminology: Adjacent vertices, degree of a vertex, isolated vertex, pendant vertex in a undirected graph, The handshaking Theorem for an undirected graph (statement only), Theorem: An undirected graph has an even number odd vertices (statement only).

   (c) Some special simple graphs (by simple examples): Complete graph, cycle, wheel in a graph, Bipartite graph, regular graph.

   (d) Representing graphs and graph isomorphism: Adjacency matrix of a simple graph, Incidence matrix of an undirected graph,

   (e) Connectivity: Paths, circuits, simple paths, simple circuits in a graph (simple examples), Connecting paths between vertices (simple examples), Euler paths and circuits, Hamilton paths and circuits, Diracs Theorem (statement only), Ores Theorem (statement only), Planar graphs, planar representation of graphs, Eulers formula. Kuratowskis Theorem (statement only).

   (f) Algorithms: Shortest path problem: Construction of Eulerian path by Fleurys Algorithm, The shortest path algorithm - Dijkstras Algorithm, Floyds Algorithm to find the length of the shortest path.

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2. **Unit II: Preliminary Counting** **(15 Lectures)**

   (a) Finite and infinite sets, countable and uncountable sets with examples

   (b) Addition and Multiplication Principle, counting sets of pairs, Two ways counting.

   (c) Stirling numbers of second kind. Simple recursion formulae satisfied by $S(n;k)$ for $k = 1, 2, \cdots, n1, n$

   (d) Pigeonhole principle and its strong form, its applications to geometry, monotonic sequences etc.

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3. **Unit III: Advanced Counting** **(15 Lectures)**

   (a) Binomial and Multinomial Theorem, Pascal identity, examples of standard identities with emphasis on combinatorial proofs.

   (b) Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems.

   (c) Non-negative and positive solutions of equation $x_1 + x_2 + \cdots + x_k = n$

   (d) Principal of inclusion and exclusion, its applications, derangements, explicit formula for d_n, deriving formula for Eulers function $\phi(n)$

Recommended Books:

1. R. Wilson, Introduction to Graph theory, Fourth Edition, Prentice Hall.
2. K. H. Rosen, Discrete Mathematics and Its Applications, McGraw Hill Edition.
3. B. Kolman, Robert Busby, Sharon Ross: Discrete Mathematical Structures, Prentice-Hall India.
4. N. Biggs, Discrete Mathematics, Oxford.
5. Norman Biggs: Discrete Mathematics, Oxford University Press.
6. Richard Brualdi: Introductory Combinatorics, John Wiley and sons.
7. V. Krishnamurthy: Combinatorics-Theory and Applications, Affiliated East West Press.
8. Discrete Mathematics and its Applications, Tata McGraw Hills.
9. Schaums outline series: Discrete mathematics,
10. Applied Combinatorics: Allen Tucker, John Wiley and Sons

Additional Reference Books:

1. D. B. West, Introduction to graph Theory, Pearson.
2. F. Harary, Graph Theory, Narosa Publication.
3. Graham, Knuth and Patashnik, Concrete Mathematics, Pearson Education Asia Low Price Edition.

Suggested Practicals (Sem III)

1. Drawing a graph, counting the degree of vertices and number of edges.
2. Representing a given graph by an adjacency matrix and drawing a graph having given matrix as adjacency matrix.
3. Determining whether the given graph is connected or not. Finding connected components of a graph. Finding strongly connected components of a graph. Finding cut vertices.
4. Problems based on counting principles, Two way counting.
5. Stirling numbers of second kind, Pigeon hole principle.
6. Multinomial theorem, identities, permutation and combination of multi-set.
7. Inclusion-Exclusion principle. Euler phi function.
8. Miscellaneous theory quesitons from all units.

Syllabus for Semester-IV

USC4MT1: CALCULUS-IV

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

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1. **Unit I: Riemann Integration** **(15 Lectures)**
   Approximation of area, Upper/Lower Riemann sums and properties, Upper/Lower integrals, Definition of Riemann integral on a closed and bounded interval, Criterion of Riemann integrability, if $a < c < b$ then $f \in \mathbb{R}[a,b]$,if and only if $f \in \mathbb{R}[a,c]$ and $f \in R[c,b]$ and $\int_a^b f = \int_a^c f + \int_c^b f$ Properties:
   (a) $f, g \in R[a,b] \implies f+g, f-g, \lambda f \in R[a,b]$
   (b) $\int_a^b (f+g) = \int_a^b f + \int_a^b g$
   (c) $\int_a^b \lambda(f) = \lambda \int_a^b f$
   (d) $f \in R[a,b] \implies \mid f \mid \in R[a,b]$ and $\mid \int_a^b f \mid \leq \int_a^b \mid f \mid$
   (e) If $f \geq 0, and f \in C[a,b] \implies f \in R[a,b]$
   (f) If f is bounded with finite number of discontinuities then $f \in R[a,b]$, generalize this if f is monotone then $f \in R[a,b]$

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2. **Unit II : Indefinite and improper integrals** **(15 lectures)**
   Continuity of $F(x) = \int_a^x f(t)dt$ where $f \in R[a,b]$, Fundamental theorem of calculus, Mean value theorem, Integration by parts, Leibnitz rule, Improper integrals type 1 and type 2, Absolute convergence of improper integrals, Comparison tests, Abels and Dirichlets tests (without proof).

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3. **Unit III : Applications** **(15 lectures)**
   (a) β and Γ functions and their properties, relationship between β and Γ functions (without proof).
   (b) Applications of definite Integrals : Area 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.

References:

1. Calculus Thomas Finney, ninth edition section 5.1, 5.2, 5.3, 5.4, 5.5, 5.6.
2. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
3. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.
4. T. Apostol, Calculus Vol.2, John Wiley.
5. K. Stewart, Calculus, Booke/Cole Publishing Co, 1994.
6. J. E. Marsden, A.J. Tromba and A. Weinstein, Basic multivariable calculus.
7. Bartle and Sherbet, Real analysis.

Suggested Practicals (Sem IV)

1. Calculation of upper sum, lower sum and Riemann integral.
2. Problems on properties of Riemann integral.
3. Problems on fundamental theorem of calculus, mean value theorems, integration by parts, Leibnitz rule.
4. Convergence of improper integrals, applications of comparison tests, Abels and Dirichlets tests, and functions.
5. Beta Gamma Functions
6. Problems on area, volume, length.
7. Miscellaneous Theoretical Questions based on full paper

USC4MT2: ALGEBRA-IV
(LINEAR ALGEBRA-II)

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

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1. **Unit I: Inner Product Spaces** **(15 Lectures)**

   (a) Dot product in $\mathbb{R}^n$, Definition of general inner product on a vector space over $\mathbb{R}$ and examples

   (b) Norm of a vector in an inner product space. Cauchy-Schwarz inequality, Triangle inequality, Orthogonality of vectors, Pythagoras theorem and geometric applications in $\mathbb{R}^2$, Projections on a line, The projection being the closest approximation, Orthogonal complements of a subspace, Orthogonal complements in $\mathbb{R}^2$ and $\mathbb{R}^3$. Orthogonal sets and orthonormal sets in an inner product space, Orthogonal and orthonormal bases. Gram-Schmidt orthogonalization process, Simple examples in $\mathbb{R}^3$,$\mathbb{R}^4$

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2. **Unit II: Eigenvalues and eigenvectors** **(15 Lectures)**

   (a) Eigenvalues and eigenvectors of a linear transformation $T : V \to V$, where V is a finite dimensional real vector space, Eigenvalues and eigenvectors of linear transformations examples.

   (b) Eigenvalues of $n \times n$ real matrices.

   (c) The linear independence of eigenvectors corresponding to distinct eigenvalues of a linear transformation.

   (d) The characteristic polynomial of an $n \times n$ real matrix, characteristic roots.

   (e) Similar matrices, characteristic polynomials of similar matrices.

   (f) The characteristic polynomial of a linear transformation $T : V \to V$, where V is a finite dimensional real vector space.

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3. **Unit III: Diagonalization** **(15 Lectures)**

   (a) Diagonalizability of an $n \times n$ real matrix and a linear transformation of a finite dimensional real vector space to itself. Definition : Geometric multiplicity and Algebraic multiplicity of eigenvalues of an $n \times n$ real matrix and of a linear transformation.

   (b) An $n \times n$ matrix A is diagonalisable if and only if $\mathbb{R}^n$has a basis of eigenvectors of A if and only if the sum of dimension of eigenspaces of A is n if and only if the algebraic and geometric multiplicities of eigenvalues of A coincide. Examples of non diagonalizable matrices.

   (c) orthogonal diagonalization and Quadratic Forms.

(d) orthogonal diagonalization of $n \times n$ real symmetric matrices.

Recommended Books:

1. Serge Lang: Introduction to Linear Algebra, Springer Verlag.
2. S. Kumaresan: Linear Algebra A geometric approach, Prentice Hall of India Private Limited.

Additional Reference Books:

1. M. Artin: Algebra, Prentice Hall of India Private Limited.
2. K. Hoffman and R. Kunze: Linear Algebra, Tata McGraw-Hill, New Delhi.
3. Gilbert Strang: Linear Algebra and its applications, International Student Edition.
4. L. Smith: Linear Algebra, Springer Verlag.
5. A. Ramachandra Rao and P. Bhima Sankaran: Linear Algebra, Tata McGrawHill, New Delhi.
6. T. Banchoff and J. Wermer: Linear Algebra through Geometry, Springer Verlag Newyork, 198
7. Sheldon Axler : Linear Algebra done right, Springer Verlag, Newyork.
8. Klaus Janich : Linear Algebra.
9. Otto Bretcher: Linear Algebra with Applications, Pearson Education.
10. Gareth Williams: Linear Algebra with Applications, Narosa Publication.

Suggested Practicals (Sem IV)

1. Inner Product Spaces, examples. Orthogonal complements in $\mathbb{R}^2$and $\mathbb{R}^3$
2. Gram-Schmidt method
3. Finding characteristic polynomial, eigenvalues of 2×2 and 3×3 matrices.
4. Eigenvalues and eigenvectors of linear transformation
5. Diagonalization and orthogonal diagonalization.
6. Orthogonal Diagonalization Forms
7. Miscellaneous Theoretical Questions based on full paper

USC4MT3: ORDINARY DIFFERENTIAL EQUATIONS

Note: All topics have to be covered with proof in details (unless mentioned otherwise) and with examples.

1. **Unit I: Second order Linear Differential equations** **(15 Lectures)**

   (a) First order and first degree differential equations

   (b) Homogeneous and non-homogeneous second order linear differentiable equations: The space of solutions of the homogeneous equation as a vector space. Wronskian and linear independence of the solutions. The general solution of homogeneous differential equations. The general solution of a non-homogeneous second order equation. Complementary functions and particular integrals.

   (c) The homogeneous equation with constant coefficients. auxiliary equation. The general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation.

   (d) Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameters.

2. **Unit II: Power Series solution of ordinary differential equations (15 Lectures)**

   (a) A review of power series.

   (b) Power series solutions of first order ordinary differential equations.

   (c) Regular singular points of second order ordinary differential equations.

   (d) Frobenius series solution of second order ordinary differential equations with regular singular points.

3. **Unit III: Laplace Transforms** **(15 Lectures)**

   (a) Introduction, Properties of Laplace transform

   (b) Laplace transform of elementary functions Problems using properties-Laplace transform of special function, unit step function and Dirac delta function

   (c) Laplace transform of derivatives and Integrals, Evaluation of integral using Laplace Transform, Initial Value Theorem, Final Value Theorem and problems, Laplace Transform of periodic function

   (d) Introduction, Properties of inverse Laplace transform, Problems (usual types)

   (e) Convolution Theorem, Inverse Laplace Transform using Convolution theorem

Recommended Books:

1. G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 1972.
2. E. A. Coddington , An Introduction to Ordinary Differential Equations. Prentice Hall, 1961.
3. W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiely, 2013.
4. D. A. Murray, Introductory Course in Differential Equations, Longmans, Green and Co., 1897.
5. A. R. Forsyth, A Treatise on Differential Equations, MacMillan and Co., 1956.
6. Dr. S. Sreenath, S.Ranganatham, Dr. M.V.S.S.N.Prasad and Dr. V. Ramesh Babu, Fourier Series and Integral Transforms, S.Chand and Company Ltd

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Additional Reference Books:

1. M.K. Venkataraman, Engineering Mathematics volume 3,National Publishing Co.
2. P.Kandasamy and others, Engineering Mathematics volume 3,S.Chand and Co.
3. Stanley Grossman and William R.Devit, Advanced Engineering Mathematics, Harper and Row publishers
4. Murray R Spiegel, Schaum's Outline of Laplace Transforms

Suggested Practicals (Sem IV)

1. Finding general solution of homogeneous and non-homogeneous equations, use of known solutions to find the general solution of homogeneous equations.
2. Solving equations using method of undetermined coefficients and method of variation of parameters.
3. Power series solutions of first order ordinary differential equations.
4. Frobenius series method for second order ordinary differential equations.
5. Laplace transform of elementary functions
6. Laplace transform of derivatives and Integrals
7. inverse Laplace transform & Convolution theorem
8. Miscellaneous
