List of New Courses Introduced

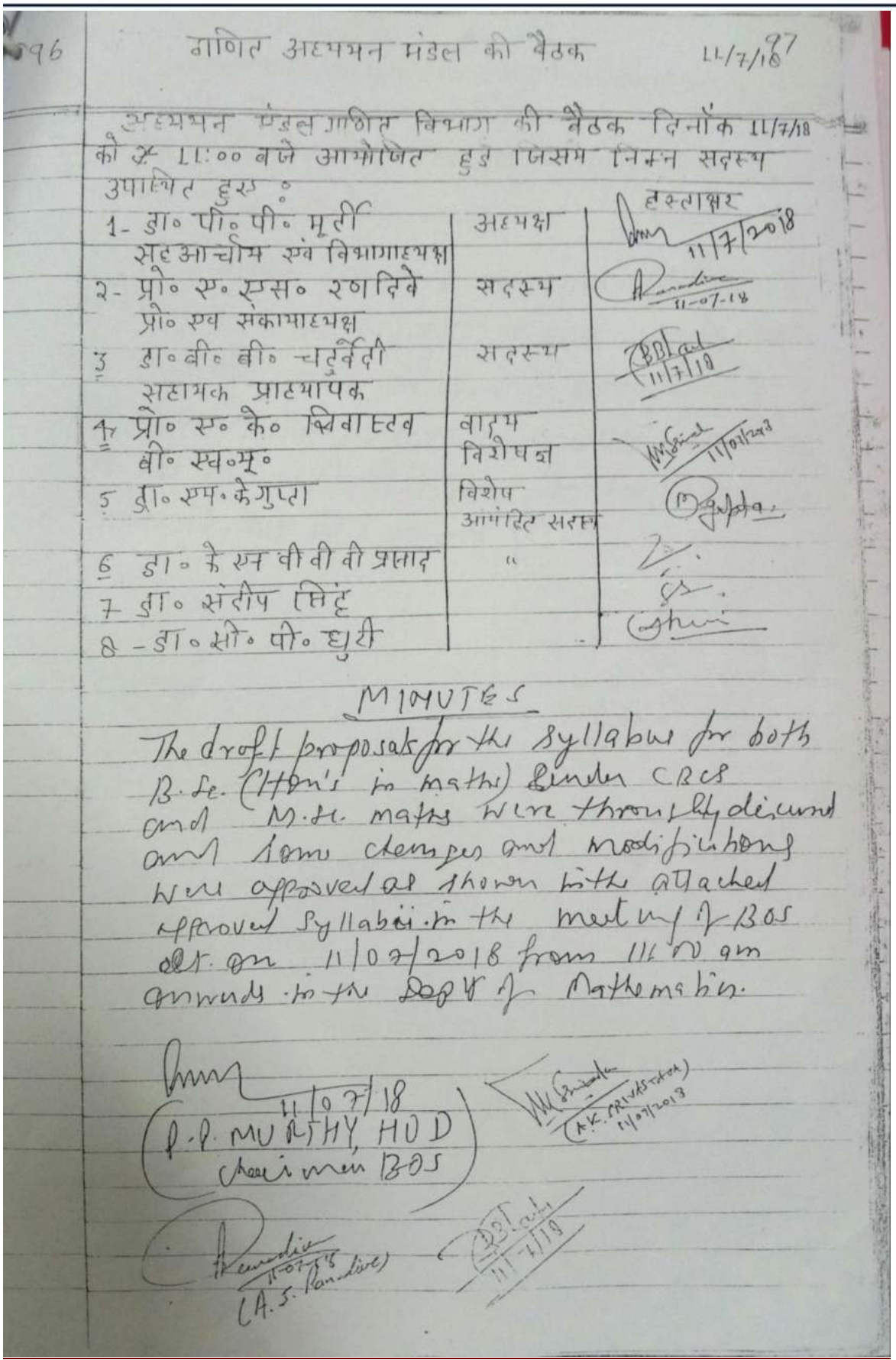
Department : *Mathematics*

Program Name : *B.Sc., MSc.*

Academic Year : 2018-19

List of New Courses Introduced

Sr. No.	Course Code	Name of the Course
01.	C1.1	Calculus
02.	C1.2	Algebra
03.	GE1.1	Differential Calculus
04.	GE1.2	Object Oriented Programming in C++
05.	GE1.3	Finite Element Methods
06.	C2.1	Real Analysis
07.	C2.2	Differential Equations
08.	GE2.1	Algebra and Matrix Theory
09.	GE2.2	Mathematical Finance
10.	GE2.3	Econometrics
11.	MSC 1.1	Algebra-I
12.	MSC 1.2	Real analysis
13.	MSC1.3	Topology-I
14.	MSC1.4	Differential Geometry-I
15.	MSC1.5	Discrete Mathematical Structures
16.	MSC2.1	Algebra-II
17.	MSC2.2	Complex Analysis
18.	MSC2.3	Topology-II
19.	MSC2.4	Differential Geometry-II
20.	MSC2.5	Graph Theory



96 गणित अध्ययन मंडल की बैठक 11/7/18

अध्ययन मंडल गणित विभाग की बैठक दिनांक 11/7/18 को अ 11:00 बजे आयोजित हुई जिसमें निम्न सदस्य उपस्थित हुए :

		हस्ताक्षर
1- डा० पी० पी० मूर्ती सह आचार्य एवं विभागाध्यक्ष	अध्यक्ष	11/7/2018
2- प्रो० ए० एस० रणदिवे प्रो० एवं संकायाध्यक्ष	सदस्य	11-07-18
3 डा० बी० बी० चतुर्वेदी सहायक प्राध्यापक	सदस्य	11/7/18
4- प्रो० ए० के० त्रिवास्तव बी० एच०यू०	वाह्य विशेषज्ञ	11/07/18
5 डा० एम० के गुप्ता	विशेष आमंत्रित सदस्य	
6 डा० के एस वी वी प्रसाद	"	
7 डा० संदीप मिंहे		
8 - डा० सी० पी० धुरी		

MINUTES

The draft proposals for the syllabus for both B.Sc. (Hons's in maths) under CBCS and M.Sc. maths were throughly discussed and some changes and modifications were approved as shown in the attached approved Syllabii in the meeting of BOS held on 11/07/2018 from 11:00 am onwards in the Dept of Mathematics.

11/07/18
(P.P. MURTHY, HOD
Chairman BOS)

(A.K. SRIVASTAVA)
11/07/2018

(A.S. Ranadive)
11-07-18

New Minutes of Meeting of Board of studies

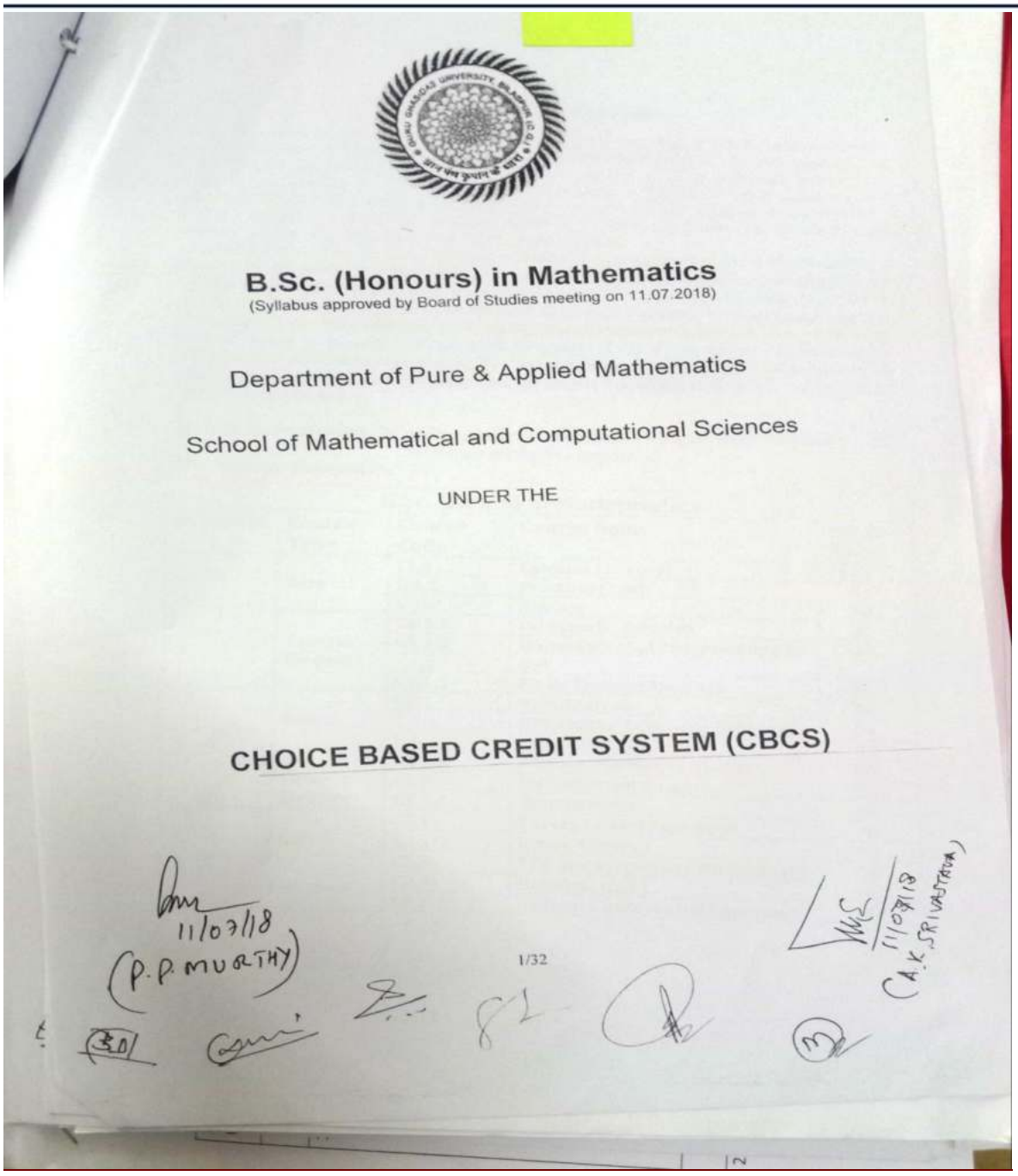
(11/07/2018)

The draft proposals for the syllabus for both B.Sc. (Hon's in Mathematics) under CBCS and M.Sc. Mathematics were thoroughly discussed and some changes and modifications were approved as shown with attached approved syllabi in the meeting of BOS on 11/07/2018 from 11:00 am onwards in the Dept. of Mathematics.

List of New Courses Introduced for the session 2018-19

Sr. No.	Programme Name	Course Code	Name of the course
01.	B.Sc.	C1.1	Calculus
02.	B.Sc.	C1.2	Algebra
03.	B.Sc.	GE1.1	Differential Calculus
04.	B.Sc.	GE1.2	Object Oriented Programming in C++
05.	B.Sc.	GE1.3	Finite Element Methods
06.	B.Sc.	C2.1	Real Analysis
07.	B.Sc.	C2.2	Differential Equations
08.	B.Sc.	GE2.1	Algebra and Matrix Theory
09.	B.Sc.	GE2.2	Mathematical Finance
10.	B.Sc.	GE2.3	Econometrics
11.	M.Sc.	MSC 1.1	Algebra-I
12.	M.Sc.	MSC 1.2	Real analysis
13.	M.Sc.	MSC1.3	Topology-I
14.	M.Sc.	MSC1.4	Differential Geometry-I
15.	M.Sc.	MSC1.5	Discrete Mathematical Structures
16.	M.Sc.	MSC2.1	Algebra-II
17.	M.Sc.	MSC2.2	Complex Analysis
18.	M.Sc.	MSC2.3	Topology-II
19.	M.Sc.	MSC2.4	Differential Geometry-II
20.	M.Sc.	MSC2.5	Graph Theory

विभागाध्यक्ष
Head
गणित विभाग
Department of Mathematics
गुरु घासीदास विश्वविद्यालय,
Guru Ghasidas Vishwavidyalaya,
बिलासपुर (छ.ग.) 495009, भारत
Bilaspur (C.G.), 495009, India



B.Sc. (Honours) in Mathematics

(Syllabus approved by Board of Studies meeting on 11.07.2018)

Department of Pure & Applied Mathematics

School of Mathematical and Computational Sciences

UNDER THE

CHOICE BASED CREDIT SYSTEM (CBCS)

11/07/18 (P.P. MURTHY)

1/32

11/07/18 (A.K. SRIVASTAVA)

SCHEME OF EXAMINATION

All papers of B.Sc.(Honors'in Mathematics) **First, Second, Third** and **Fourth** Semesters are compulsory. In **Fifth** and **Sixth** Semesters **TWO PAPERS(02)** are **core papers** and each student has to choose three papers from the list of given **optional papers**. An examinee has to attempt total five (05) questions out of eight(08) i.e. one compulsory and four optional. Question No. 1 is compulsory and will consist of short answered type ten(10) questions spread all over the syllabus carrying 20 marks (2 marks of each question). Rest of all questions will carry 10 marks each.

In addition to this in the final semester (i.e. Fourth Semester of M.Sc. in Mathematics) a student can choose **two optional papers** and one **project dissertation (selection based on the criteria fixed by Department Head)** under the supervision/guidance of any of the faculty members in the relevant areas of Mathematics closely to the subjects taught at M.Sc. level. Supervisor and topic of the dissertation for student is being allotted at the level of Department in consultation with HOD by a team of faculty members. The dissertation evaluation of 100 marks is evaluated by a committee **consisting of HOD, supervisor and external subject expert**. Each paper (except project dissertation) is of 100 marks and its distribution is as under:

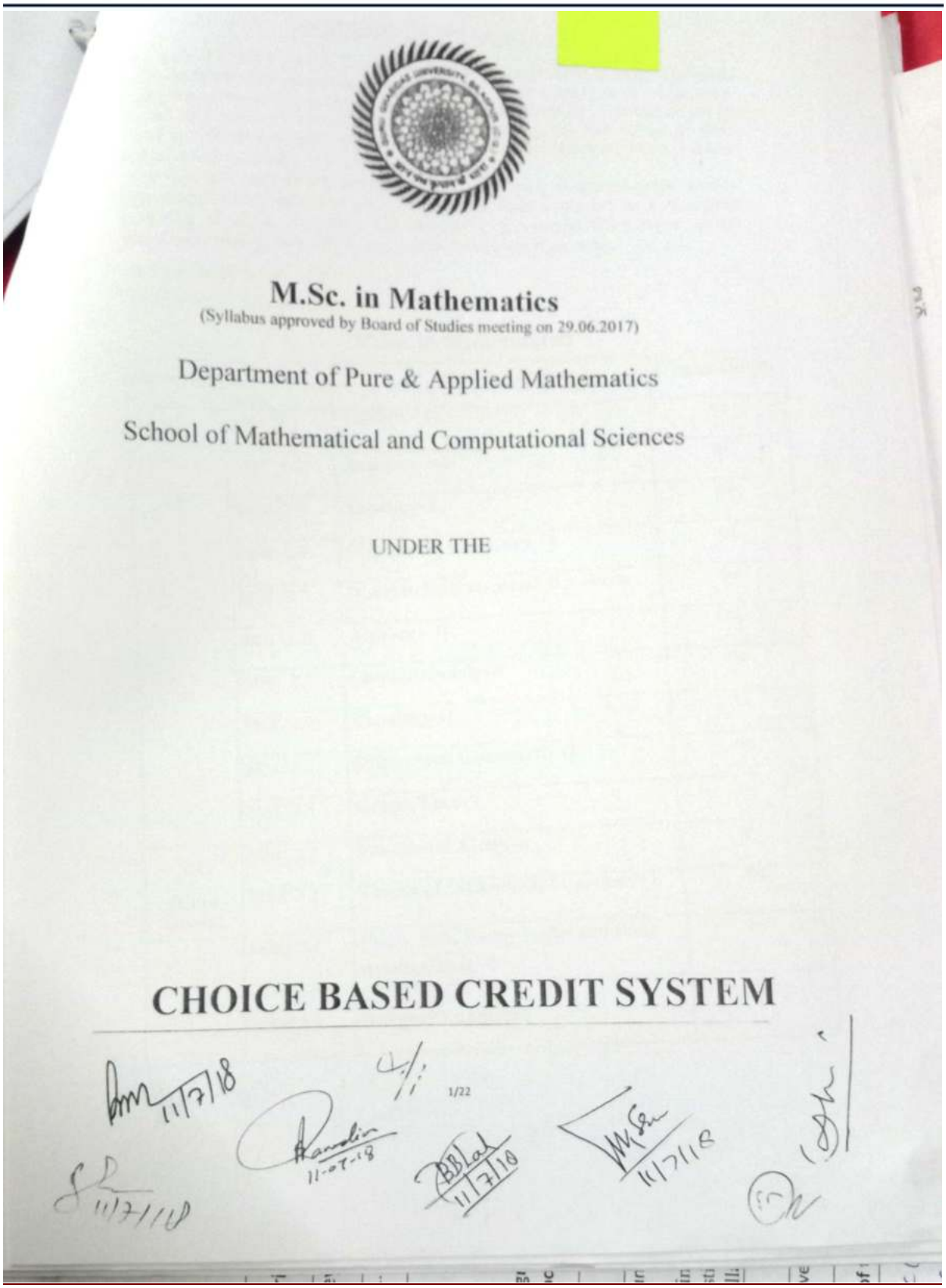
Internal Assessment:**40** (30 marks of internal examination + 05 marks of assignment + 05 maximum marks on attendance)

End Semester Examination: 60

B.Sc. (Hon's) in Mathematics

Semester	Course Type	Course Code	Course Name	Credit/ Hours
I	Core	C1.1	Calculus (Theory)	04
		C 1.1	Practical (Lab)	02
		C 1.2	Algebra	06
	Generic Elective	GE 1.1	Differential Calculus	06
		GE 1.2	Object Oriented Programming in C++	06
		GE 1.3	Finite Element Methods	06
II	Core	C2.1	Real Analysis	06
		C 2.2	Differential Equations (Theory)	04
		C 2.2	Practical (Lab)	02
	Generic Elective	GE 2.1	Algebra and Matrix Theory	06
		GE 2.2	Mathematical Finance	06
		GE 2.3	Econometrics	06
	Core	C3.1	Theory of Real Functions	06
		C3.2	Group Theory I	06
		C3.3	PDE and System of ODE (Theory)	04
		C3.3	Practical (Lab)	02
		GE 3.1	Ordinary Differential Equations	06

III	Generic Elective		and Vector Calculus	
		GE 3.2	Cryptography and Network Security	06
		GE 3.3	Information Security	06
	SEC	SEC 1.1	Logic and Sets	06
		SEC 1.2	Computer Graphics	06
IV	Core	C4.1	Numerical Methods (Theory)	04
		C4.1	Practical (Lab)	02
		C4.2	Riemann Integration and series of Functions	06
		C4.3	Ring Theory and Linier Algebra I	06
	Generic Elective	GE4.1	Partial Differential Equations, Laplace Transform and Fourier Series	06
		GE 4.2	Applications of Algebra	06
		GE 4.3	Combinatorial Mathematics	06
	SEC	SEC 2.1	Graph Theory	06
		SEC 2.2	Operating System: Linux	06
V	Core	C 5.1	Multivariate Calculus	06
		C 5.2	Group Theory II	06
	DSE (Any One)	DSE 1.1	Portfolio Optimization	06
		DSE 1.2	Number Theory	06
		DSE 1.3	Analytical Geometry	06
	DSE (Any One)	DSE 2.1	Industrial Mathematics	06
		DSE 2.2	Boolean Algebra and Automata Theory	06
		DSE 2.3	Probability and Statistics	06
VI	Core	C 6.1	Metric Space and Complex Analysis	06
		C 6.2	Ring Theory and Linear Algebra II	06
	DSE (Any One)	DSE 3.1	Theory of Equations	06
		DSE 3.2	Bio-Mathematics	06
		DSE 3.3	Linear Programming	06
	DSE (Any One)	DSE 4.1	Mathematical Modeling	06
		DSE 4.2	Mechanics	06
		DSE 4.3	Differential Geometry	06



M.Sc. in Mathematics

(Syllabus approved by Board of Studies meeting on 29.06.2017)

Department of Pure & Applied Mathematics

School of Mathematical and Computational Sciences

UNDER THE

CHOICE BASED CREDIT SYSTEM

SCHEME OF EXAMINATION

All papers of M.Sc. First and Second Semesters are compulsory. In M.Sc. Third and Fourth Semester **Two papers** are **core papers** and each student has to choose three among the given list of **optional papers (Including Project)**. A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.
Supervisor and topic of the dissertation for student will be allotted at the level of Department. The dissertation evaluation of 100 maks evaluated by a committee consisting of HOD, supervisor and external subject expert. Each paper (except project dissertation) is of 100 marks and its distribution is as under:

Internal Assessment : 40

End Semester Examination : 60

M.Sc. in Mathematics

Semester	Course code	Core Course	Credit Hours
I	MSC 1.1	Algebra - I	04
	MSC 1.2	Real Analysis	04
	MSC 1.3	Topology-I	04
	MSC 1.4	Differential Geometry - I	04
	MSC 1.5	Discrete Mathematical Structures	04
II	MSC 2.1	Algebra - II	04
	MSC 2.2	Complex Analysis	04
	MSC 2.3	Topology-II	04
	MSC 2.4	Differential Geometry - II	04
	MSC 2.5	Graph Theory	04
III (Core Group)	MSC 3.1	Functional Analysis	04
	MSC 3.2	Theory of Differential Equations –I	04
	MSO 3.1	Fuzzy Sets, Fuzzy Logic and their Applications –I	04
	MSO 3.2	Integral Equations	04

III (Optional Group ANY THREE)	MSO 3.3	Operations Research- I	04
	MSO 3.4	Differential Geometry of Manifolds	04
	MSO 3.5	Difference Equations –I	04
	MSO 3.6	Information Theory and its Applications	04
	MSO 3.7	Object Oriented Programming with C++	04
	MSO 3.8	Number Theory and Cryptography	04
IV (Core Group)	MSC 4.1	Advanced Functional Analysis	04
	MSC 4.2	Theory of Differential Equations –II	04
IV (Optional Group ANY THREE)	MSO 4.1	Fuzzy Sets, Fuzzy Logic and their Applications–II	04
	MSO 4.2	Finsler Geometry	04
	MSO 4.3	Operations Research- II	04
	MSO 4.4	Complex Manifolds	04
	MSO 4.5	Difference Equation –II	04
	MSO 4.6	Financial Mathematics and its Applications	04
	MSO 4.7	Project	04

B.Sc. Honors' Programme: DEPARTMENT OF PURE AND APPLIED MATHEMATICS

Syllabus

C1.1 Calculus

Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule, applications in business, economics and life sciences.

Reductionformulae, derivations and illustrations of reduction formulae of the type $\int \sin nx\,dx$, $\int \cos nx\,dx$, $\int \tan nx\,dx$, $\int \sec nx\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \sin mx\,dx$, volumes byslicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, modeling ballistics and planetary motion, Kepler's second law.

List of Practicals (using any software)

(i) Plotting of graphs of function e^{ax+b}, log (ax + b), $\frac{1}{ax+b}\sin(ax+b)$, cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.

(ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

(iii) Sketching parametric curves (Examples: Trochoid, cycloid, epicycloids, hypocycloid).

(iv) Obtaining surface of revolution of curves.

(v) Tracing of conics in Cartesian coordinates/ polar coordinates.

(vi) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using Cartesian coordinates.

(vii) Matrix operation (addition, multiplication, inverse, transpose).

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.

11/7/18

2/32

2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.

3. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.

4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

C1.2 Algebra

Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications.

Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of R^n and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Books Recommended

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory,* 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

3. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

C2.1 Real Analysis

Review of Algebraic and Order Properties of R, δ-neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria,

11/7/18

11/7/18

Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences.Cauchy sequence, Cauchy's Convergence Criterion.

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis,* 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis,* 2nd Ed., Jones & Bartlett, 2010.

3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis,* Prentice Hall, 2001.

4. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.

C2.2 Differential Equations

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

List of Practicals (using any software)

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).

11/7/18

4. Decay model (exponential case only).

5. Lake pollution model (with constant/seasonal flow and pollution concentration).

6. Case of single cold pill and a course of cold pills.

7. Limited growth of population (with and without harvesting).

8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).

9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).

10. Battle model (basic battle model, jungle warfare, long range weapons).

11. Plotting of recursive sequences.

12. Study the convergence of sequences through plotting.

13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.

14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.

15. Cauchy's root test by plotting n^{th} roots.

16. Ratio test by plotting the ratio of n^{th} and $(n+1)^{th}$ term.

Books Recommended

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, ADifferential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group,London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problemsComputing and Modeling,* Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

C3.1 Theory of Real Functions

Limits of functions$(\epsilon, \delta) - technique$, sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation

11/7/18

General Elective (GE)

GE 1.1 Differential calculus

Limit and Continuity: (ε, δ) definition, Types of discontinuities, Differentiability of functions, n^{th} Derivative, Successive differentiation, Leibniz rule and its applications.

Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves.
Parametric representation of curves and tracing of parametric curves.
Polar coordinates and tracing of curves in polar coordinates.

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cosx, e^x, log(1 + x), $(1 + x)^m$, Maxima and Minima, Indeterminate forms.

Functions of Two Variables: Limit, Continuity, Differentiability. Partial differentiation, Change of variables, Euler's and Taylor's theorem.Maxima and minima.

Double and triple integrals, Change of order in double integrals.Beta and Gamma functions.

Text Books

1. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
2. S. C. Mallik, Mathematical Analysis, Wiley Eastern Ltd, New Delhi.

Reference Books:

1. Gabriel Kiaumber, Mathematical Analysis, Marcel Dekkar, New York 1975.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 1999.
3. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
4. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

GE 1.2 Object Oriented Programming in C++

OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++,Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer.

Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value,Using Reference variables with Functions.

Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, publicand protected. Implementing Class Functions within Class declaration or outside the Class declaration.instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members. Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input,Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator , concepts of namespaces.

Practical to be performed in lab.

Books Recommended

1. A. R. Venugopal, Rajkumar, and T. Ravishanker, *Mastering C++*, TMH, 1997.

2. S. B. Lippman and J. Lajoie, *C++ Primer*, 3rd Ed., Addison Wesley, 2000.

3. Bruce Eckel, *Thinking in C++*, 2nd Ed., President, Mindview Inc., Prentice Hall.

4. D. Parasons, *Object Oriented Programming with C++*, BPB Publication.

5. BjarneStroustrup ,*The C++ Programming Language*, 3rd Ed., Addison Welsley.

GE 1.3 Finite Element Methods

Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin'smethod.Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

Applications to solving simple problems of ordinary differential equations.

Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries

Interpolation functions, numerical integration, and modelling considerations.

Solution of two dimensional partial differential equations under different Geometric conditions.

Books Recommended

1. J.N. Reddy, *Introduction to the Finite Element Methods*, Tata McGraw-Hill, 2003.

11/7/18

2. K.J. Bathe, *Finite Element Procedures*, Prentice-Hall, 2001.

3. R.D. Cook, D.S. Malkus and M.E. Plesha, *Concepts and Applications of Finite ElementAnalysis*, John Wiley and Sons, 2002.

4. Thomas J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite ElementAnalysis*, Dover Publication, 2000.

5. George R. Buchanan, *Finite Element Analysis*, McGraw Hill, 1994.

GE 2.1 Algebra and Matrix Theory

Sets, Relations, Function or mapping, injective and surjective mappings, Images and inverse images of a set under a mapping, Equivalence relation and partition, partial order relation and Zorn's lemma(without proof), Binary operations.

Group: Definition, examples, property. Subgroup, Union and intersection of groups, Cyclic group, order of the group, Group of symmetries and examples, Permutation group.
Ring: Definition and examples, property, Subring, Ideal, Integral Domain.

Field: Definition and , example

Matrix algebra: Introduction, Elementary operations of matrices. Inverse of a matrix. Rank of a matrix, Echlon form of a matix, Normal Form, Application of matrices to the system of linear equations, Consistency of the system of linear equations.

Books Recommended

1. Titu Andreescu and DorinAndrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

2. David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson

3. P.R. Bhattacharya, S.K. Jain and S.R.Nagapaul Basic Abstract Algebra IInd Edition cambridge University press Indian Edition 1997.

4. I.N.Herstein Topics in Algebra, Wiley Eastern Ltd. New Delhi 1975.

GE 2.2 Mathematical Finance

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers

for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.

Books Recommended

1. David G. Luenberger, *Investment Science,* Oxford University Press, Delhi, 1998.

2. John C. Hull, *Options, Futures and Other Derivatives*, 6th Ed., Prentice-Hall India, Indian reprint, 2006.

3. Sheldon Ross, *An Elementary Introduction to Mathematical Finance*, 2nd Ed., Cambridge University Press, USA, 2003.

GE 2.3 Econometrics

Statistical Concepts Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.

Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting.

Multiple Linear Regression Model Estimation of parameters; properties of OLS estimators; goodness of fit - R2 and adjusted R2 ; partial regression coefficients; testing hypotheses – individual and joint; functional forms of regression models; qualitative (dummy) independent variables.

Violations of Classical Assumptions: Consequences, Detection and Remedies Multicollinearity; heteroscedasticity; serial correlation.

Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.

Books Recommended

1. Jay L. Devore, *Probability and Statistics for Engineers*, Cengage Learning, 2010.

2. John E. Freund, *Mathematical Statistics*, Prentice Hall, 1992.

3. Richard J. Larsen and Morris L. Marx, *An Introduction to Mathematical Statistics and itsApplications,* Prentice Hall, 2011.

4. D. N. Gujarati and D.C. Porter, *Essentials of Econometrics*, McGraw Hill, 4th Ed., International Edition, 2009.

11/7/18

11/7/18

MSC 1.1: Algebra - I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Normal series - Normal and subnormal series, composition series, Jordan-Holder theorem, Solvable groups, Nilpotent groups.

Rings and Ideals - Maximal and prime ideals, Nilpotent and Nil ideals.

Modules- Definition and examples, sub modules, quotient modules, direct sums, modules generated by a subset, cyclic module, homomorphism of modules, isomorphism theorems, Exact sequence of modules, Simple modules, Semi-simple modules, Schur's lemma, Free modules.

Field Theory - Extension fields, Algebraic and transdental extensions, separable and inseparable extension, Normal extensions, Perfect fields, Finite Fields, Primitive Elements, Algebraically closed fields, Galois Extension, Fundamental theorem of Galois Theory.

Text Book:

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul Basic Abstract Algebra IInd Edition Cambridge University, Press Indian Edition.

Reference Books:

1. I.N. Herstein, Topics in Algebra Wiely Eastern Ltd. New Delhi (1975).
2. M. Artin, Algebra Prantice Hall of India 1991.
3. D.S. Malik, J.N. Mordeson & M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill International Edition 1997.

MSC 1.2: Real Analysis

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Definition and existence of Riemann-Stieltjes integral, Properties of the Integral, integration and differentiation, the fundamental theorem of Calculus, Integration of vector - valued functions. Rectifiable curves.

Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability, Non-measurable sets, Integration of Non-negative functions, The General integral, Integration of series.

Measure and outer measures, Extension of a measure , Uniqueness of Extention, Completion of a measure, Measure spaces, Integration with respect to a measure, Riemann and Lebesgue integrals.

4/22

The four derivatives, Lebesgue Differentiation theorem, Differentiation and Integration.

Functions of Bounded variation, L^P- space, convex functions, Jensen's inequality, Holder and Minkowski inequalities, completeness of L^P- space, convergence in measure, almost uniform convergence.

References:

1. R.R. Goldberg, Methods of Real Analysis.
2. W. Rudin, Principles of Mathematical Analysis.
3. R.G. Bartle, The Elements of Real Analysis (only for Fourier Series), 2nd Ed., J .Wiley, NY, London.
4. Kenneth A. Ross, Elements of Analysis: The Theory of Calculus, Springer Verlag, UTM, 1980.

MSC 1.3: Topology-I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Topological spaces, basis, subbasis, product topology (for finite case), quotient topology, subspace topology, closure, interior.

Continuous functions and their characeterization, countability Axioms, Separation Axioms, Hausdorff topological spaces, Regular topological spaces, Normal topological spaces.

Connected topological spaces, Path-connected topological spaces, continuity and connectedness, local connectedness, Connected components of a topological space, Path components of a topological space.

Compact spaces, limit point compact spaces, continuity and compactness, Tube lemma, compactness and product topology, local compactness, one point compactification.

Complete metric spaces, Completion of a metric space, Total boundedness, compactness in Metric spaces, sequentially compact metric spaces, uniform continuity, Lebesgue covering lemma.

Recommended Books

1. James Munkres: Topology, Pearson.
2. George Simmons: Topology and Modern Analysis, Tata Mcgraw-Hill.
3. M. A. Armstrong: Basic Topology, Springer UTM.
4. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York, 1995.
5. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.

5/22

6. K. D. Joshi, introduction to General topology, New Age International Pvt. Ltd. Publ., New Delhi(2006).

MSC 1.4: Differential Geometry-I

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Curves in space R^3: Arc length, tangent, osculating plane, normal plane, principal normal and binormal, curvature and torsion, Serret-Frenet formulae, Frenet's approximation, oscillating circle, osculating sphere, spherical indicatrices, involutes & evolutes, helix, intrinsic equation of a curve.

Surface in R^3: Surfaces, surfaces of revolution, helicoids, families of curves on a surface, the first and second fundamental forms of a surface, principal directions, lines of curvature, principal curvatures, and Gaussian curvature, Dupin indicatrix, normal curvature.

Books:

1. T. J. Willmore: An Introduction to Differential Geometry.
2. L. P. Eisenhart: An Introduction to Differential Geometry.
3. M. Spivak: A Comprehensive Introduction to Differential Geometry.

MSC 1.5: Discrete Mathematical Structures

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Formal logic: Statements and logical connectives (negation conjunction disjunction) and formulas. Truth tables conditional and bi-conditional statements, well-formed formulas, tautologies and contradiction, equivalent formulas, duality law, functionally complete set of connectives, two state devices and logic gates, normal forms, principle conjunctive and principle disjunctive normal forms. The theory of inference for the statement calculus, rules of inference, automatic theorem proving method, the predicate calculus: predicate, quantifiers, , free and bound variables, inference theory of the predicate calculus.

Semigroup and Monoid: Semi groups and monoids, concatenation operation, Homomorphism of semi groups and monoids, congruence relations and quotient semi groups, sub semi groups and sub monoids. Direct products. Basic homomorphism theorem.

Lattices: Lattices as partially ordered sets, their properties, lattices as algebraic

systems, sub lattices, directs products and homomorphism, complete, complimented and distributive lattices.

Boolean Algebra: Boolean algebra as lattices, various Boolean identities , The switching algebra, sub-algebra, direct products, homomorphism, join irreducible elements and min-terms, Boolean forms and their equivalences, min-term Boolean forms, sum-of-products and products-of-sum canonical forms, minimization of Boolean functions, application of Boolean algebra to switching theory (using AND, OR and NOT Gates), Karnaugh map.

Text Books:

1. J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. C. L. Liu, Elements of Discrete Mathematics, Mc-Graw Hill Book Company.

Reference Books:

1. S. Witala, Discrete Mathematics: A Unified Approach, Mc-Graw Hill Book Company.
2. S. Lepschutz, Finite Mathematics, Mc-Graw Hill Book Company.

MSC 2.1: Algebra - II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Algebra of Linear transformations, Characteristics roots and matrices for linear transformations, Canonical Forms - Similarity of Linear transformations invariant subspaces, Reduction to triangular form, Nilpotent transformation, Index of Nilpotency, Invariants of a nilpotent transformation, the primary decomposition theorem. Jordan blocks and Jordan forms.

Noetherian and Artinian Modules and rings, Hilbert's Basis theorem, Wedderburn Artin Theorem, Smith Normal form over a PID and Rank.

Fundamental structure theorem for finitely generated modules over a principal Ideal Domain and its applications to finitely generated abelian groups. Rational canonical form, Generalized Jordan form over any field.

Text Books:

1. P.R. Bhattacharya, S.K. Jain and S.R.Nagapaul Basic Abstract Algebra IInd Edition cambridge University press Indian Edition 1997.
2. I.N.Herstein Topics in Algebra, Wiley Eastern Ltd. New Delhi 1975.

Reference Books:

1. M.Artin Algebra, Prentice Hall of India 1991.
2. D.S.Malik, J.N. Mordeson & M.K. Sen, Fundamentals of Abstract Algebra Mc-Graw Hill International Edition.

7/22

MSC 2.2: Complex Analysis

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Conformable transformations and Bilinear transformations, Harmonic conjugates, transformations of Harmonic functions, Transformations of Boundary conditions, stedy temperatures, steady temperature in a Half plane, temperatures in a quadrant, electrostatic potential, potential in a cylinderical space, two-dimensinal fluid flow, the stream function, flows around a corner and around a cylinder.

Line integrals, primitive, Cauchy's Theorem for a disc, Cauchy's theorem and applications, Cauchy's estimate, Cauchy integral formula, Entire functions, Louville's theorem, Morera's theorem.

Complex power series, Taylor's series, Sequences and series of functions, Uniform convergence, Power series, radius of convergence of a power series.

Singularities, Isolated singularities, poles and essential singularities, Laurent Series, removable singularities, Riemann's theorem, Casorati-Weirstrass theorem, Argument principle, Rouche's theorem.

Holomorphic functions and their properties, Maximum modulus theorem, zeros of analytic functions, analytic continuation.

Cauchy's Residue Theorem and its applications, evaluation of standard types of integrals by the residue calculus method.

References:

1. James W. Brown & Ruel V. Churchill: Complex variables and applications, Mcgraw-Hill Asia. Churchill, Brown, Complex Analysis - Ed. V
2. J. B. Conway, Functions of One Complex Variable.
3. Serge Lang: Complex Analysis, Springer.
4. R. Remmert: Theory of complex functions, Springer.

MSC 2.3: Topology-II

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Product topology: Tychonoff product topology (arbitrary case) and its characterizations, Tychonoff theorem .

Projection maps. Connectedness and product spaces. Compactness and product spaces (Tychonoff's theorem) Urisohn's Lemma. Stone Catch Compactification.

Homotopy, Path homotopy, The fundamental group, Simply connected spaces, Covering spaces, Path lifting and homotopy lifting lemma, Fundamental group of the circle. Deformation retracts and homotopy types, Fundamental group of S_n; Fundamental group of the projective space, Brower fixed point theorem, Fundamental theorem of algebra, Borsuk-Ulam theorem.

Text Book:

1. James R. Munkres, Topology, A First Course in Topology, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1963.

Reference Books:

1. J. Dugundji, Topology, Allyn and Bacon, 1966 (Reprinted in India by Prentice Hall of India Pvt. Ltd.)
2. J. L. Kelley, General Topology, Van Nostrand, Reinhold Co. New York, 1995.
3. S. Willard, General Topology, Addition-Wesley, Regarding, 1970.

MSC 2.4: Differential Geometry -II

M.M. 60

Note: *A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.*

Surface in R^3: Conjugate curves, asymptotic lines, developablesurface, minimal surfaces, ruled surfaces, Christoffel symbols, Gauss-Weingarten formulae, Gauss equations, Codazzi-Mainardi equations, the Riemannian curvature tensor, geodesics on surface of revolution, geodesic curvature of a curve.

Tensors and differential forms: Tensor product of vector spaces, tensor fields, differential forms, exterior derivative, orientation of manifolds, covariant differentiation, identities satisfied by forms, exterior derivation, identities satisfied by curvature and torsion tensors, the Koszul connexion.

Books:

1. T. J. Willmore: An Introduction to Differential Geometry, Oxford University Press, New York, 1959.
2. L. P. Eisehart: An Introduction to Differential Geometry, Princeton University Press, Princeton, New Jersey,1940.
3. M. Spivak: A compressive Introduction to Differential Geometry.
4. T. J. Willmore: Riemannian Geometry, Oxford University Press, USA.

9/22

MSC 2.5: Graph Theory

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Definition of undirected graphs, Four colour theorem, paths, circuits, cycles and subgraphs. Induced subgraphs degree of a vertex, connectivity. Planar graphs and their properties, tree, Euler's formula for connected planer graphs, complete and complete biparted graphs. Kuratowaski's theorem (Statement only) and its use.

Spanning trees, cut sets, fundamental cut sets and cycles. Minimal spanning trees. Matrix representation of graphs. Euler's Theorem on the existence of Eulirian path and circuits. Directed graphs, in degree and out degree of the vertex, weighted undirected graphs, Shortest path problems.

Finite state machine and their transition table diagrams, equivalence of finite state machine, reduced machines

Text Books:

1. J. P. Trembly and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Company, 1977.
2. J. L. Gersting, Mathematical structures for Computer Science, III- Edition, Computer Sci. Press New York.
3. C. L. Liu, Elements of Discrete Mathematics, Mc-Graw Hill Book Company.
4. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India.

Reference Book:

1. S. Lepschutz, Finite Mathematics, Mc-Graw Hill Book Company.

MSC 3.1: Functional Analysis

M.M. 60

Note: A candidate has to attempt five questions. Question No. 1 is compulsory which will consist of short answered type ten questions spread all over the syllabus carrying 20 marks (2 marks each). Rest all questions will carry 10 marks each.

Normed linear spaces, properties of normed spaces, subspaces, Banach spaces, compactness and finite dimensional spaces, linear operators, bounded and continuous linear operators, linear functional, linear operators and functional on finite dimensional spaces, normed spaces of operators, dual spaces.

Hahn-Banach theorem, complex normed linear spaces, applications to bounded linear functionals on C[a,b], adjoint operators, reflexive spaces, Category theorem, Uniform boundedness theorem and some of its consequences, strong and weak convergence, convergence of a sequence of operators and functionals, Open mapping theorem and closed graph theorem.

10/22