DEPARTMENT OF HIGHER EDUCATION

RAJA MAHENDRA PRATAP SINGH

UNIVERSITY

ALIGARH

Syllabus for Fourth to Sixth Year of Higher Education (FYUP & P.G.)
According to-
National Education Policy-2020

U.G. (Honour's) or U.G. (Honour's with Research) / P.G.

in

MATHEMATICS

SYLLABUS DEVELOPED BY-				
S.N.	**NAME**	**DESIGNATION**	**DEPARTMENT**	**COLLEGE / UNIVERSITY**
1	PROF. SHUBHNESH KUMAR GOYAL	Professor	Mathematics	D.S.(P.G.) COLLEGE, ALIGARH
2	DR. VISHAL KUMAR YADAV	Assistant Professor	Mathematics	D.S.(P.G.) COLLEGE, ALIGARH
3	DR. HEMANT KUMAR	Assistant Professor	Mathematics	VEERANGANA AVANTIBAI GOVT. COLLEGE, ATRAULLI
4	DR. ROHIT MANGLIK	Assistant Professor	Mathematics	S.V. COLLEGE, ALIGARH
REVIEWED BY-				
1	PROF.(Smt.) PARVEEN RANA	Professor	Mathematics	D.S.(P.G.) COLLEGE, ALIGARH
2	PROF. JYOTSNA CHANDEL	Professor	Mathematics	D.S.(P.G.) COLLEGE, ALIGARH
3	PROF. REKHA RANI	Professor	Mathematics	S.V. COLLEGE, ALIGARH
4	PROF. OMVIR SINGH	Professor	Mathematics	S.V. COLLEGE, ALIGARH
5	PROF. RAJESH JAUHARY	Professor	Mathematics	AGRA COLLEGE, AGRA
6	PROF. UDAYRAJ SINGH	Professor	Mathematics	C.L. JAIN COLLEGE, FIROZABAD
7	DR. MANJUBALA	Associate Professor	Mathematics	S.V. COLLEGE, ALIGARH
8	DR. ANUP KUMAR GUPTA	Assistant Professor	Mathematics	GANJ. COLLEGE, GANJDUNDWARA

SEMESTER WISE TITLES OF THE PAPER IN PG MATHEMATICS COURSE

YEAR	SEMESTER	COURSE CODE	PAPER TITLE	THEORY/PRACTICAL	CREDIT	TOTAL
COURSES FOR BACHELOR OF SCIENCE (HONOURS) & (HONOURS WITH RESEARCH)						
4TH YEAR / 1ST YEAR	VII	RB030701T	ADVANCED ORDINARY DIFFERENTIAL EQUATION	THEORY	4	20/ 16
		RB030702T	ADVANCED REAL ANALYSIS	THEORY	4	
			Choose both for U.G. (Honour's) and one for U.G. (Honour's with Research)-			
		RB030703T	i. ADVANCED LINEAR ALGEBRA	THEORY	4	
		RB030704T	ii. PROBABILITY AND STATISTICS	THEORY	4	
		RB030705P	COMPUTER MATHEMATICS WITH PROGRAMMING	PRACTICAL	4	
	VIII	RB030801T	ADVANCED PARTIAL DIFFERENTIAL EQUATION	THEORY	4	20/24
		RB030802T	ADVANCED COMPLEX ANALYSIS	THEORY	4	
		RB030803T	ADVANCED ABSTRACT ALGEBRA	THEORY	4	
			Choose both for U.G. (Honour's) and one for U.G. (Honour's with Research)-			
		RB030804T	i. INTEGRAL EQUATIONS & CALCULUS OF VARIATION	THEORY	4	
		RB030805T	ii. ADVANCED NUMERICAL ANALYSIS	THEORY	4	
		RB030806R	**Research Project (Submission and Evaluation) For the student of U.G. (Honour's with Research) only**		8	
M.Sc. MATHEMATICS						
5TH YEAR / 2ND YEAR	IX	RB030901T	FUZZY SETS AND FUZZY LOGICS	THEORY	4	16
		RB030902T	TOPOLOGY	THEORY	4	
			Choose any one -			
		RB030903T	i. RIGID DYNAMICS	THEORY	4	
			or			
		RB030904T	ii. MODULE THEORY			
		RB030905P	PRACTICAL IN MATLAB/MATHEMATICA	PRACTICAL	4	
	X	RB031001T	FLUID DYNAMICS	THEORY	4	24
		RB031002T	FUNCTIONAL ANALYSIS	THEORY	4	
		RB031003T	OPERATIONS RESEARCH	THEORY	4	
			Choose any one -			
		RB031004T	i. SPECIAL FUNCTION	THEORY	4	
			or			
		RB031005T	ii. MATHEMATICAL CRYPTOGRAPHY			
		RB031005R	**Research Project (Submission and Evaluation)**		8	

PROPOSED STRUCTURE OF PG MATHEMATICS SYLLABUS

AS PER NEP 2020 GUIDELINES GENERAL OVERVIEW

COURSES FOR BACHELOR OF SCIENCE (HONOURS) & (HONOURS WITH RESEARCH)									
PROGRAMME	**YEAR**	**SEMESTER (15Weeks)**	**PAPER**	**CREDIT**	**PERIODS Per Week**	**PERIODS (HOURS) Per Semester**	**PAPER TITLE**	**UNIT (Periods Per Semester)**	**PREREQUISITE**
BACHELOR OF SCIENCE WITH HONOURS AND HONOURS WITH RESEARCH	FOURTH YEAR	SEMESTER – VII	**Paper-1 THEORY**	4	4	4x 15= 60	ADVANCED ORDINARY DIFFERENTIAL EQUATION	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-2 THEORY	4	4	4x 15= 60	ADVANCED REAL ANALYSIS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-3 THEORY	4	4	4x 15= 60	ADVANCED LINEAR ALGEBRA	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-4 THEORY	4	4	4x 15= 60	PROBABILITY AND STATISTICS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-5 PRACT.	4	4	2x4x 15 = 120	COMPUTER MATHEMATICS WITH PROGRAMMING	Unit I (30) UNIT II(30) UNIT III(30) UNIT IV(30)	B.Sc. Mathematics
		SEMESTER – VIII	**Paper-1 THEORY**	4	4	4x 15= 60	ADVANCED PARTIAL DIFFERENTIAL EQUATION	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-2 THEORY	4	4	4x 15= 60	ADVANCED COMPLEX ANALYSIS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-3 THEORY	4	4	4x 15= 60	ADVANCED ABSTRACT ALGEBRA	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-4 THEORY	4	4	4x 15= 60	INTEGRAL EQUATIONS & CALCULUS OF VARIATIONS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
			Paper-5 THEORY	4	4	4x 15= 60	ADVANCED NUMERICAL ANALYSIS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc. Mathematics
				8	**Research Project For the student of U.G. (Honour's with Research) only**				

M.Sc. (MATHEMATICS)

PROGRAMME	YEAR	SEMESTER (15Weeks)	PAPER	CREDIT	PERIODS Per Week	PERIODS(HOURS) Per Semester	PAPER TITLE	UNIT (Periods Per Semester)	PREREQUISITE
M.Sc. IN APPLIED MATHS	FIFTH YEAR	SEMESTER – IX	**Paper-1 THEORY**	4	4	4x 15= 60	FUZZY SETS AND FUZZY LOGICS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-2 THEORY	4	4	4x 15= 60	TOPOLOGY	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-3 THEORY	4	4	4x 15= 60	OPTIONAL ELECTIVE: Select one of the courses- RIGID DYNAMICS Or MODULE THEORY	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15))	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-4 PRACT.	4	4	2x4x 15 = 120	PRACTICAL IN MATLAB/MATHEMATICA	Unit I (30) UNIT II(30) UNIT III(30) UNIT IV(30)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
		SEMESTER – X	**Paper-1 THEORY**	4	4	4x 15= 60	FLUID DYNAMICS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-2 THEORY	4	4	4x 15= 60	FUNCTIONAL ANALYSIS	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-3 THEORY	4	4	4x 15= 60	OPERATIONS RESEARCH	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
			Paper-4 THEORY	4	4	4x 15= 60	OPTIONAL ELECTIVE: Select one of the courses- Special Function Or MATHEMATICAL CRYPTOGRAPHY	Unit I (15) UNIT II(15) UNIT III(15) UNIT IV(15)	B.Sc.(Honours) Or B.Sc. (Honours with Research)
				8	**RESEARCH PROJECT**				

RAJA MAHENDRA PRATAP SINGH

UNIVERSITY

ALIGARH

Detailed Syllabus For

BACHELOR OF SCIENCE

HONOURS / HONOURS WITH RESEARCH

in

MATHEMATICS

B.Sc. (Honours/Honours with Research) (SEMESTER-VII) PAPER-I
ADVANCED ORDINARY DIFFERETIAL EQUTIONS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 7th**
Subject: Mathematics		
Course Code: RB030701T	**Course Title: ADVANCED ORDINARY DIFFERETIAL EQUTIONS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED ORDINARY DIFFERETIAL EQUTIONS

Unit	Topics	No. of Lectures
I	Total Differential Equation, Solution of Total Differential Equation containing three or more variables, Non-Linear Ordinary differential Equation of Particular Form, Riccati's Equation- General solution when one, two or three Particular Solution are known.	15
II	Ordinary points, Singularities, Regular and Irregular singular points, Series Solutions about ordinary points, Frobenius series solution.	15
III	Orthogonal and Orthonormal Sets of Functions, Eigen Values and Eigen Functions, Sturm-Liouville's Boundary Value Problem, Green's Functions, Procedures of constructing Green's function, Properties of Green's function, Dirac-Delta Function.	15
IV	Existence and Uniqueness of solution of first order differential equations, Method of Successive Approximations, Lipchitz conditions, Convergence of Successive Approximations.	15

Suggested Readings-

1. Coddington, Earl A. & Levinson, Norman: Theory of Ordinary Differential equations, Tata McGraw-Hill Publication.

2. Rai,B., Chaudhary, D.P. and Freedman, H.I.: A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi 2013.

3. Simmons, G.F.: Differential Equations with Applications and Historical Notes, Second Edition, TMH Publishing Co. Ltd. New Delhi (2017).

4. Wirkus Stephen A & Swift, Randall J.: A Course in Ordinary Differential Equations 1st Edition, CRC Press, Taylor & Francis Group, 2015.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation/** Research Orientation assignment	5
4	**Assignment**	5

B.Sc. (Honours/Honours with Research) (SEMESTER-VII) PAPER-II

ADVANCED REAL ANALYSIS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 7th**
Subject: Mathematics		
Course Code: RB030702T	**Course Title: ADVANCED REAL ANALYSIS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED REAL ANALYSIS

Unit	Topics	No. of Lectures
I	Field & order structure, Boundedness of set, Supremum and Infimum Equivalent sets, Infinite sets, Countable & Uncountable sets with their properties, Cardinal numbers and related results, closed set, open set, limit point, closure of set, Isolated point, adherent point, Interior exterior & Boundary point, Dense set, Perfect set, Compactness, Heine Borel theorem, Connectedness, Cantor Set and its properties, Cantor function, Generalized Cantor set, Archimedean property, Bolzano Weierstrass theorem for set.	**15**
II	Riemann integral and its algebra & property, The fundamental theorem of Calculus, Riemann-Stieltjes Integral, Sequences and series of functions, Pointwise and Uniform Convergence, Cauchy criterion and Weierstrass M-test, Uniform convergence and continuity, Dini's theorem. Functions of bounded Variation, Variation of function, Power Series.	**15**
III	Set Function, Measurable sets and their properties, Algebra of measurable sets, Sets of Measure zero, F-sigma set and G-delta sets, Borel measurable sets, non-measurable sets and their related results, Measurable functions, Non- Measurable function and related results, Convergence of sequence of measurable functions, Convergence Almost Everywhere, Step Function, Characteristic function and its properties, Simple function.	**15**
IV	The Lebesgue Integral, Properties of Lebesgue integral for bounded measurable functions, Lebesgue Integral of a bounded function over a set of finite measure, Lebesgue Integral on unbounded sets or integral, comparison of Lebesgue Integral with Riemann Integral, Bounded convergence theorem, Monotone convergence theorem.	**15**

Suggested Readings-

1. Apostol, T. M.: Mathematical Analysis, Narosa Publishing, New Delhi, 1985
2. Royden, H. L.: Real Analysis, (4th Edition), Macmillan Publishing Co. Inc. New York, 1993.
3. Rudin, W.: Principles of Mathematical Analysis, (3rd edition) McGraw-Hill, Kogaku Sha, 1976, International student edition.
4. White, J.: Real Analysis, An Introduction, Addison-Wesley Publishing, Co. Inc., 1968.
5. Robert G. Bartle and Donald R. sherbert: Introduction to Real Analysis, Wiley Student Edition,
6. S. C. Malik and Savita Arora: Mathematical Analysis, New Age International Publishers, New Delhi.
7. Shanti Narayan and M. D. Raisinghania: Elements of Real Analysis, S. Chand and Company Limited, New Delhi.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VIII) PAPER-III

ADVANCED LINEAR ALGEBRA

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 7th**
Subject: Mathematics		
Course Code: RB030703T	**Course Title: ADVANCED LINEAR ALGEBRA**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED LINEAR ALGEBRA

Unit	Topics	No. of Lectures
I	Linear transformations, Isomorphism, Range and null space, The matrix representation of a linear transformations, Linear functionals, Double dual, Invertibility and Isomorphisms, The change of coordinate matrix, The transpose of a linear transformations.	**15**
II	Inner product spaces: Bessel's inequality, Grahm Schmidt Process of Orthonormalization, Normal and Unitary operators. Jordan forms: Cyclic subspaces and annihilators, Cyclic decomposition and the rational form, The Jordan form.	**15**
III	Elementary Canonical forms: Annihilating polynomials, The minimal polynomial, Invariant subspaces, Simultaneous triangulation, Simultaneous diagonalization, Direct-sum decomposition, Invariant direct sums, The primary decomposition theorem.	**15**
IV	Orthogonal and Unitary reduction of Quadratic and Hermitian form, Positive definite Quadratic forms, Simultaneous Reduction. Bilinear forms, Matrix of a Bilinear form, Classification of Bilinear forms: Symmetric Bilinear forms, Skew-symmetric Bilinear forms.	**15**

Suggested Readings-

1. David C.Lay, Steven R.Lay and Judi J.MC Donald; Linear Algebra and Its Applications, 6th Edition Pearson Education 2021.

2. Hoffman, K., Kunze R.: Linear Algebra (2nd Edition), Pearson, 2017.

3. Friedberg, S.H., Insel, A.J., Spence, L.E.: Linear Algebra Pearson Education India, 2015.

4. Strang, G. Linear Algebra and its Applications (4th Edition), Cengage Learning, 2007.

5. Sahai, V. and Bist, V.: Linear Algebra (2nd Edition), Narosa Publishing House, 2013.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VII) PAPER-IV
PROBABILITY AND STATISTICS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 7th**
Subject: Mathematics		
Course Code: RB030704T	**Course Title:** PROBABILITY AND STATISTICS	
Credits: 4	**Core Compulsory /Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

PROBABILITY AND STATISTICS

Unit	Topics	No. of Lectures
I	Measurement of Central Tendency, Dispersion, Skewness, Kurtosis and Variance, Correlation and Regression.	**15**
II	Probability: Set theoretic approach, Sample spaces, Events, Dependent and Independent events, Random variables, Distribution functions, Joint probability distribution function, Conditional distribution function, Probability density function, Expectation, Covariance, Variance of variables, standard errors, Marginal and Conditional distributions.	**15**
III	Basics concept of Moment generating function, Probability generating function and Universal generating function, Discrete distributions: Geometric, Bernoulli, Binomial, Poisson and uniform distributions, Continuous distributions: Normal, Exponential, Gamma, Chi-square, student's t and F and Beta distributions.	**15**
IV	Sampling Methods: Random Sampling Methods, Simple Random sampling, Stratified Sampling, Systematic Sampling, Probability Proportional to size sampling, Test of Hypothesis and significance: Statistical Hypothesis (Simple and composite), Null and alternative hypotheses, Tests for Significance, Testing the significance for population mean and variance for t-distribution and Chi-square distribution.	**15**

Suggested Readings-

1. Rohatgi, V.K., Saleh, A.K. Md. Ehsanes: An Introduction to Probability and Statistics, Second Edition Wiley-Inderscience. (2008)
2. Kennedy and Gentle: Statistics Computing, Published by CRC Press. (2021)
3. Mayer, P.L.: Introductory Probability and Statistical Applications, IBH. 2nd Edition (1970)
4. Mood, A.M. and Graybill, F.: Introduction to the Theory of Statistics, McGraw Hill Education; 3rd edition (2017).
5. Hogg, R.V., Craig, A. and McKean, Joseph W.: Introduction to Mathematical Statistics, Pearson Education, .8th Edition New Delhi (2019)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VII) PAPER-IV

COMPUTER MATHEMATICS WITH PROGRAMMING

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 7th**
Subject: Mathematics		
Course Code: RB030705P	**Course Title:** COMPUTER MATHEMATICS WITH PROGRAMMING	
Credits: 4	**Core Compulsory**	
Max. Marks: 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8		

COMPUTER MATHEMATICS WITH PROGRAMMING

Unit	Topics	No. of Lectures
	History And Scope of Computer, Control Unit and Memory Unit of Computer OPERATING SYSTEM: Different Operating System (Windows, Linux, Mac etc.) File Systems: MS-Office- Word, Excel, Power Point Presentation-Creation, Saving, Editing and Printing, LATEX. Number System: Decimal, Binary, Octal, Hexa-Decimal Numbers and Their Operations, ASCII Code Algorithms And Flow Charts Introduction of Fortran Programming. Execution of Simple Fortran Programs based On- Do-Loops, Nested Do-Loops Function and Subroutine Array and Dimension.	**120**

Suggested Readings-

1. MATHEMATICS FOR COMPUTER SCIENCE BY F.T. LEIGHTON, 2010.
2. CONCRETE MATHEMATICS BY DONALD KNUTH, 1988.
3. FOUNDATION OF MATHEMATICS FOR COMPUTER MATHEMATICS BY JOHNS VINCE, 2015.
4. MATHEMATICAL SOFTWARES BY ICMC, ELSEVIER.

B.Sc. (Honours/Honours with Research) (SEMESTER-VIII) PAPER-I
ADVANCED PARTIAL DIFFERETIAL EQUTIONS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 8th**
Subject: Mathematics		
Course Code: RB030801T	**Course Title: ADVANCED PARTIAL DIFFERETIAL EQUTIONS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED PARTIAL DIFFERETIAL EQUTIONS

Unit	Topics	No. of Lectures
I	Origin of first order Partial Differential Equations (PDEs), Lagrange method for solving first order PDEs, Integral surfaces passing through a given curve, Surface orthogonal to a given system of surface, Non-linear PDEs of the first order, Charpit's method for first order PDEs, Linear PDEs with constant and variable coefficients, Cauchy problem for first order PDEs.	**15**
II	Origin of second order partial differential equation and their classification, General solution of higher order PDEs with constant coefficient, Reduction of second order partial differential equation into its canonical form, Non-linear partial differential equations of second order.	**15**
III	Solution of Wave, Heat and Laplace equations by the method of separation of variables Vibration governed by one- and two-dimensional wave equations, Vibrations of string and membranes, three dimensional Vibrations problems, Solution by spherical means, Non-homogeneous equations, Energy methods.	**15**
IV	Laplace's equation: Fundamental solution, Mean value formulas, Properties of Harmonic functions, Energy methods. Heat equation: Fundamental solution; Mean value formula, Properties of solutions, Energy methods.	**15**

Suggested Readings-

1. Sneddon, Ian: Elements of Partial Differential Equation, McGraw-Hill Book Company.
2. Evans, L.C.: Partial Differential Equations, Graduate Studies in Mathematics, Volume 19, AMS, 1998.
3. John, F.: Partial Differential equations, Springer- Verlag, N.Y., 2013.
4. Prasad, P. and Ravindran, R.: Partial Differential Equations (2nd Edition), New Age International Pub, New Delhi, 2011.

This course can be opted as an elective by the students of following subjects: M.Sc. PHYSICS/ M.Sc. (C.S.)/ MCA/M.STAT.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VIII) PAPER-II

ADVANCED COMPLEX ANALYSIS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 8th**
Subject: Mathematics		
Course Code: RB030802T	**Course Title: ADVANCED COMPLEX ANALYSIS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED COMPLEX ANALYSIS

Unit	Topics	No. of Lectures
I	Topology of Complex Plane, Sequence and series of complex numbers, Cauchy criterion for convergence in C, Tests for convergence, Absolutely Convergent, Sequence and Series of functions, Uniform Convergence, Weierstrass's M-test, Weierstrass' Theorem for uniform convergence, Analytic and Harmonic functions and their properties, Power series, Root and Ratio tests, Exponential, Trigonometric and Logarithmic functions and their properties.	**15**
II	Complex integrals, Properties of complex line integrals, Weak form of Cauchy's Theorem, Cauchy-Goursat Theorem, Simply and multiply connected domains, Cauchy's Integral formula, Higher Order Derivatives of Analytic function, Gauss's Mean- Value Theorem, Winding number (or Index of a curve), Cauchy's Inequality, Morera's Theorem, Poisson's Integral Formula for a Circle, Zeros of Analytic functions, Classifications of Singularities, Meromorphic and entire functions, Maximum modulus principle, Rouche's theorem, Schwarz Lemma, The fundamental theorem of Algebra.	**15**
III	Analytic continuation, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Schwarz' Reflection Principle. Conformal mappings, Circle and inverse points with respect to a Circle, some elementary transformations, Linear fractional transformation, Cross Ratio, The Transformations $w = z^n$, (where n is a positive integers), $w = z^2$, $w = e^z$, w = log z, w = c sinz, w= tan z .	**15**
IV	Residue at a Finite Point, Residue at the Point at Infinity, Residue Theorem, Evaluation Of Real Definite Integrals By Contour Integration, Integrals of Type $\int_{\alpha}^{\alpha+2\pi} R(cost, sint)\, dt$, Integrals of Type $\int_{-\infty}^{\infty} f(x)dx$, Integrals of Type $\int_{-\infty}^{\infty} g(x)coxmxdx$, Singularities on the Real Axis, Jordan's Inequality, Jordan's Lemma. Integral function, Mittag-Leffler's Theorem, Weierstrass' factorization theorem, Canonical products, Jensen and Poisson-Jensen formulae, maximum modulus of an entire function, Order of an entire function.	**15**

Suggested Readings-

1. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi.
2. H. S. Kasana, Complex Variables, Theory and Applications, PHI Learning Pravate Limited, Delhi.
3. Churchill, R. V. and Brown, J. W. Complex Variables and Applications. 9th edition, McGraw Hill Education, 2014.
4. A first Course in Complex Analysis with Applications, Dennis G. Zill and Patrick D. Shanahan, Jones & Bartlett Student Edition, New Delhi.57. Theory and Problems of Complex Variables, Schaum's Outline Series, Mc-Graw Hill Book Company, Singapore.
5. Edward,S. B. and Snider, Arthur D. Fundamental of Complex Analysis with Applications to Engineering and Sciences. Pearson Education, 2014.
6. Lang, S. Complex Variable. Springer, 2013. 6. Conway J. B. Functions of One Complex Variable. Springer, 2000.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VII) PAPER-III
ADVANCED ABSTRACT ALGEBRA

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 8th**
Subject: Mathematics		
Course Code: RB030803T	**Course Title: ADVANCED ABSTRACT ALGEBRA**	
Credits: 4	**Core Compulsory/ Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED ABSTRACT ALGEBRA

Unit	Topics	No. of Lectures
I	Direct products, External Direct products, Internal Direct products, Sylow p-subgroups, Sylow's first theorem, Double cosets, Sylow's second and third theorem, Applications of Sylow's theorem. Structure Theory of Finite Abelian Groups, Simplicity Test of Groups, The Dihedral Group.	**15**
II	Cauchy's theorem for finite abelian group, Cauchy's theorem for an arbitrary finite group, Fundamental theorem on homomorphism of groups, Second and third law of isomorphism of groups, Maximal subgroup, Composition series, Jordon Holder's theorem, Subnormal and normal series, Solvable groups, Characteristic property of solvable groups.	**15**
III	Field extension: Fundamental theorem of field theory, Algebraic and Transcendental extension, finite extension, Normal and separable extension, Splitting field, Field extensions, Finite field extensions, Simple field extensions, Algebraic and transcendental extensions.	**15**
IV	Finite fields, Galois theory- Automorphism of field, Galois group, Galois extension, Fundamental theorem of Galois theory, Finite fields, Structure of finite fields, Subfields of finite fields. Splitting field, Separable extension, Perfect field, Automorphisms of a field, Group of automorphisms of a field, Fixed field, Normal extensions.	**15**

Suggested Readings-

1. David S. Dummit & Richard M. Foote: Abstract Algebra, Wiley, 3rd Edition, 2011

2. Joseph A. Gallian: Contemporary Abstract Algebra 9th Edition, 2019.

3. Khanna, Vijay K & Bhambri, S K A Course in Abstract Algebra, S Chand and Company Ltd; Fifth edition (2022)

4. Herstein, I.N.: Topics in Algebra, Wiley, 2nd Edition, 2006.

5. Bhattacharya, P.B., Nagpaul, S.K. Basic Abstract Algebra (2nd Edition) Cambridge University Press, Indian Edition, 1997.

6. Lang, S.: Algebra, Pearson Education 3rd Edition, 1992.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VIII) PAPER-IV
INTEGRAL EQUATIONS & CALCULUS OF VARIATIONS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 8th**
Subject: Mathematics		
Course Code: RB030804T	**Course Title:** INTEGRAL EQUATIONS & CALCULUS OF VARIATIONS	
Credits: 4	**Core Compulsory/Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

INTEGRAL EQUATIONS & CALCULUS OF VARIATIONS

Unit	Topics	No. of Lectures
I	Definitions of Integral equations and their classification, Relation between Integral and Differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations.	**15**
II	Eigen values and eigen functions, Iterated kernels, Iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.	**15**
III	Hilbert Schmidt theory, Symmetric kernels, Orthonormal systems of functions. Fundamental properties of eigenvalues and eigen functions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory.	**15**
IV	**Calculus of Variations**- Basic elements of the calculus of variations. Necessary condition for an extremum. Euler's equation with the cases of one variable and several variables. Variational problems for functional involving several dependent variables, Invariance of Euler's equations. Variational problems in parametric form. Functionals depending on higher order derivatives.	**15**

Suggested Readings-

1. Kanwal,R. P., Linear Integral Equation, Theory and Technique, 2nd edition, 1996, Academic Press New York 1971.

2. Gupta,A.S., Calculus of Variations with Applications, Ist edition, PHI, India.

3. Hildebrand, F. B., Method of Applied Mathematics, 2nd edition, PHI, India

4. M.D. Raisinghania, A Text Book of INTEGRAL Equation

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

B.Sc. (Honours/Honours with Research) (SEMESTER-VIII) PAPER-V
ADVANCED NUMERICAL ANALYSIS

Programme: B.Sc. (Honours/Honours with Research	**Year: Fourth**	**Semester: 8th**
Subject: Mathematics		
Course Code: RB030805T	**Course Title: ADVANCED NUMERICAL ANALYSIS**	
Credits: 4	**Core Elective/Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

ADVANCED NUMERICAL ANALYSIS

Unit	Topics	No. of Lectures
I	Modified Newton-Raphson method, Convergence of Newton Raphson Method, Newton-Raphson method for solving Nonlinear Simultaneous Equations with two or more variables, Multiple roots of Transcendental Equations, Bairstow method. Graffe's root squaring method for polynomial equations, Bairstow method.	**15**
II	Approximation: Least square polynomial approximation, polynomial approximation using orthogonal polynomials, Legendre's approximation, Approximation with trigonometric functions, Exponential functions, Rational functions. Approximation by Chebyshev polynomials, Max-min principle.	**15**
III	Numerical Solution of Partial Differential Equation, Finite-difference approximations to partial derivatives, Notation for functions of several variables, Solution of Laplace equation, One dimension heat equation, One dimensional wave equation, Solution of wave equation.	**15**
IV	Algebraic eigen values and eigen vectors: Power methods, Jacobi's method, Given's method, Householder's method and Q-R method.	**15**

Suggested Readings-

1. Froberg, C.E.: Introduction to Numerical Analysis, Addison-Wesley Pub. Co., 2016.

2. Gupta, Radhey S.: Elements of Numerical Analysis, Macmillan India Ltd. New Delhi, 2015.

3. Jain, M.K., Iyengar, S.R.K and Jain, R.K.: Numerical Methods for Scientific and Engineering Computations, New Age International (P) Ltd. New Delhi, 2014.

4. Sastry, S.S.: Introductory Methods of Numerical Analysis, UBS Publishers, 2012.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

RAJA MAHENDRA PRATAP SINGH UNIVERSITY

ALIGARH

Detailed Syllabus For

M.Sc.

in

MATHEMATICS

M.Sc. (MATHS.) (SEMESTER-IX) PAPER-I
FUZZY SETS AND FUZZY LOGICS

Programme: M.Sc. (MATHEMATICS)	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB030901T	**Course Title: FUZZY SETS AND FUZZY LOGICS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

FUZZY SETS AND FUZZY LOGICS

Unit	Topics	No. of Lectures
I	Basics concepts on crisp sets, Fuzzy sets, α-cuts, Additional properties of α-cuts, Level sets, Cardinality of Fuzzy Sets, Types of fuzzy sets, L-Fuzzy Sets, Convex fuzzy sets, Decomposition Theorems, Extension principle for fuzzy sets.	**15**
II	Operations of Fuzzy Sets: Fuzzy complement, Fuzzy union. Fuzzy intersection, T-norms, T-conorms, combination of operations, General aggregation Operations. Fuzzy numbers: Concept of Fuzzy Number, Types of Fuzzy Numbers (Triangular and Trapezoidal), Arithmetic operations on Fuzzy Numbers. Fuzzy Relations: Fuzzy relations, Projections and Cylindric extensions, Binary fuzzy relations, binary relations on single set, Fuzzy equivalence relations, Fuzzy partial order relations, Fuzzy ordering relations. Fuzzy ranking method.	**15**
III	Fuzzy logic and Possibility theory: Fuzzy propositions, Fuzzy quantifiers, Linguistic hedges, Inference from conditional fuzzy propositions, Inference from conditional and qualified propositions, Fuzzy measures; description of axioms, properties of fuzzy measure, Possibility theory, Evidence theory; Belief measure, plausibility measure, properties of plausibility measure; necessity measure, properties of possibility and necessity measure, relation between belief measure and plausibility measure.	**15**
IV	Fuzzy Controller and Fuzzy Inference System: Fuzzification, Defuzzification (Center of area (COA), Center of maxima (COM), Min of max method (MOM), Center of sums, Weighed average method) Fuzzy rules, Fuzzy controller, Fuzzy inference systems (Mamdani, Sugeno's and Tsukamoto).	**15**

Suggested Readings-

1. Dubosis Didler and Prade, Henri, Fuzzy Sets and systems Theory and Applications, Academic Press, New York, 1980
2. Klir. Georage. J and Yuan Bo, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India, New Delhi. 2009
3. Lee, Kwang H., First Course on Fuzzy Theory and Applications, Springer International Edition, 2009.
4. Ross, Timothy J., Fuzzy Logic with Engineering Applications, McGraw Hills inc., 2004 New Delhi
5. Zimmermann,H.J. Fuzzy Set Theory & its Applications, Allied Publishers Ltd. New Delhi, 2006.
6. Driankov D., Hellendoorn H. and Reinfrank M., An Introduction to Fuzzy Control, Narosa Pub., 2001.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

M.Sc. (MATHS.) (SEMESTER-IX) PAPER-II
TOPOLOGY

Programme: **M.Sc. (MATHEMATICS)**	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB030902T	**Course Title: TOPOLOGY**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

TOPOLOGY

Unit	Topics	No. of Lectures
I	Topological space and its properties, Intersection and Union of Topologies, metrizable spaces, Open set, Closed sets, Neighbourhood, Bases and sub-bases, Limit point, Derived sets, Closure, Interior, Exterior and Boundary points, Dense set, Subspaces topology, Hereditary Property, Continuity, The pasting lemma, Homeomorphism, Topological Property.	**15**
II	Separated Sets, Connected and Disconnected sets, Connectedness on the real line, Continuity and Connectedness, Components, Totally and Locally connected spaces, Compact spaces and Compact subsets, Finite Intersection Property (FIP), Bolzano Weierstrass Property (BWP), Compactness in R, Heine Borel Theorem, Countable, Sequential and Local compactness, Continuity and compactness.	**15**
III	Countability axioms First and second countable spaces, Lindelof spaces, Separable spaces, Separation axioms T0, T1, T2 or Hausdorff spaces, Regular, T3, T3(1/2) and their characterizations.	**15**
IV	Normal spaces, T4-axiom and their characterizations, Urysohn's lemma and Tietze Extension Theorem, Statement of Urysohn's Metrization Theorem, Complete normal or T5-spaces, Tychonoff space, Product Spaces.	**15**

Suggested Readings-

1. General Topology, J. L. Kelley, Van Nostrand, 1995.
2. Introduction to General Topology, K. D. Joshi, Wiley Eastern, 1983.
3. Topology, James R. Munkres, 2nd Edition, Pearson International, 2000.
4. Introduction to Topology and Modern Analysis, George F. Simmons, Mc Graw-Hill, 1963.
5. General Topology, S. Willard, Addison-Wesley, 1970.
6. Basic Topology, M. A. Armstrong, Springer, 1983.
7. Topology, K. Chandrasekhara Rao, Alpha Science International, 2009.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

M.Sc. (MATHS.) (SEMESTER-IX) PAPER-III
RIGID DYNAMICS

Programme: M.Sc. (MATHEMATICS)	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB030903T	**Course Title: RIGID DYNAMICS**	
Credits: 4	**Core Compulsory /Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

RIGID DYNAMICS

Unit	Topics	No. of Lectures
I	Moment and Product of Inertia of a Rigid Body, Equi-Momental Bodies, Momental Ellipsoid, Principal Axes and Principal Moments at a Point.	**15**
II	Motion of a Body under Finite Forces: Motion on an Inclined Plane with Friction, Slipping of Rods, Motion of One Symmetric Body on Other, Motion of One Symmetric Body Within the Other Body.	**15**
III	Generalized Coordinates, Degree of Freedom, Lagrange's and Hamilton's Equations of Motion.	**15**
IV	Motion In Three-Dimensional Space, Euler's Dynamical Equation's in absence and presence of External Forces, Motion of Top.	**15**

Suggested Readings-

1. Goldstein, H.: Classical Mechanics (3rd Edition), Pearson New International Edition, 2014, ISBN 13: 9780201657029.

2. Rana, N.C. and Joag, P.S.: Classical Mechanics, Tata McGraw Hill, New Delhi.

3. Gelfand, I.M., Fomin, S.V. and Silverman, R.A.: Calculus of Variations, Prentice Hall, 2000

4. Rana, N.C. and Joag, P.S.: Classical Mechanics, Tata McGraw Hill, New Delhi, 1991.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

M.Sc. (MATHS.) (SEMESTER-IX) PAPER-IV
MODULE THEORY

Programme: M.Sc. (MATHEMATICS)	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB030904T	**Course Title: MODULE THEORY**	
Credits: 4	**Core Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

MODULE THEORY

Unit	Topics	No. of Lectures
I	Modules, Submodule, Factor Modules, Module Homomorphism, Correspondence Theorem, Isomorphism Theorem.	15
II	Bimodules, Linear combinations and spanning Set, Socle, Linearly Independent set, Bases and Rank Modules.	15
III	Simple Modules, Cyclic Modules, Unitary Modules, Noetherian Modules, Artinian Modules, Free Modules, Bases and Rank of Free Modules.	15
IV	Divisibility of Modules, Projective Modules, Connection between Divisibility and Projective Modules, Direct sum of Projective Modules, Injective Modules, Finitely Generated Modules.	15

Suggested Readings-

1. Jain, Nagpal, S.R. Bhattacharya P.B. “Basic Abstract Algebra”
2. Keating, M.E. “A First Course in Module Theory”
3. IBRAHIM ASSEM, F.U. COELHO “An introduction of Module Theory”
4. T.S. BLYTH, “Module Theory: Approach to Linear Algebra”
5. TOMA ALBU, “Ring and Module Theory”

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation/** Research Orientation assignment	5
4	**Assignment**	5

M.Sc. (MATHS.) (SEMESTER-IX) PAPER-V
PRACTICAL IN MATLAB/MATHEMATICA

Programme: M.Sc. (MATHEMATICS)	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB030905P	**Course Title: PRACTICAL IN MATLAB/MATHEMATICA**	
Credits: 4	**Core Compulsory**	
Max. Marks: 100	**Min. Passing Marks: 40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-8		

PRACTICAL IN MATLAB/MATHEMATICA

Unit	Topics	No. of Lectures
	Computer Networking: Internet, Web Browsers, Search Engines. MS Word: Handling graphics tables and charts, Formatting in MS-Word MS Power Point: Creating Slide Show, Screen Layout and Views, Applying Design Template. MS Excel: Features, Formulas and Functions, Data Analysis and Data Visualization in Excel. Scientific writing and presentation: Writing a research paper, survey article. Thesis writing: LaTeX, PS Tricks etc. Software for Mathematics: Mathematica /MATLAB /Scilab/GAP. **Programming Applications:** Exponential Growth, Exponential Decay, Linear Programming Problems, Numerical Solution of Boundary Value Problems.	**120**

Suggested Readings-

1. Nicholas J. Hingham, Handbook of Writing for the Mathematical Sciences, Second Edition, SIAM, 1998.
2. Norman E. Steenrod, Paul R. Halmos, Menahem M. Schiffer, Jean A. How to Write Mathematics, American Mathematical Society, 1973.
3. Lamport. L., LaTeX, a Document Preparation System, 2nd Ed., Addison-Wesley, 1994.
4. Shortis. Tim: The Language of ICT: Information and Communication Technology, Taylor & Francis, 2016.
5. A GUIDE TO MATLAB BY B.R. HUNT, R.L. LIPSMAN & J.M. ROSENBERG, CAMBRIDGE UNIV. PRESS.

M.Sc. (MATHS.) (SEMESTER-X) PAPER-I
FLUID DYNAMICS

Programme: **M.Sc. (MATHEMATICS)**	**Year: Fifth**	**Semester:10th**
Subject: Mathematics		
Course Code: RB031001T	**Course Title:** FLUID DYNAMICS	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

FLUID DYNAMICS

Unit	Topics	No. of Lectures
I	Lagrangian's and Euler's method, steady and unsteady flow, Stream lines, Path lines, Streak lines, Equation of Continuity, Velocity Potential, Concept of Source, Sink and Doublets, Image of Source and Doublets with respect to Plane and Circular boundaries. Rotational and Irrotational flow, General Motion of Fluid Element, Vorticity, Flow and Circulation, Stoke's Theorem, Kelvin's Circulation Theorem, Blasius Theorem with Applications, Kutta-Joukowski Theorem.	**15**
II	Vortex Motion: Vorticity And Circulation, Complex Potential Due to a Vortex, Vortex Street, Karmann's Vortex Street, Vortex Pair, Vortex inside the circular Boundaries, Properties of Vortex Lines.	**15**
III	Fluid Wave: Types Of Waves, Stationary Waves, Energy of wave, Group velocity of Waves, Wave Propagation on Common Surface of Two Fluids, Wave Propagation on a Finite, Infinite Canal, Long Wave propagation through vertical boundaries.	**15**
IV	Navier-Stoke's Equations of Viscous Fluid, Laminar Flow Between Parallel Plates, Plane Couette Flow, Plane Poiseuille Flow, Hagen's Poiseuille's Flow, Dissipation of Energy, Steady Flow Between Co-Axial Circular Pipes, Laminar Flow Between Concentric Rotating Cylinders, Laminar Flow Between Two Slowly Rotating Spheres. Boundary Layer Theory.	**15**

Suggested Readings-

1. Betchelor, G.K. An Introduction of Fluid Mechanics, Oxford University Books, New Delhi, 2000.
2. Charlton, F.: Text Book of Fluid Dynamics, CBS Publishers, Delhi, 2004.
3. Raisinghania, M.D.: Fluid Dynamics: with Complete Hydrodynamics and Boundary Layer Theory, S. Chand Publishing, 2014, ISBN 13: 9788121908696.
4. Rathy, R.K.: An Introduction of Fluid Dynamics, Oxford and IBH Publishing Co., New Delhi, 1976.
5. Yuan, S.W.: Foundations of Fluid Mechanics, Prentice Hall of India Private Limited, New-Delhi, 1988., ISBN10: 0133298132.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

M.Sc. (MATHS.) (SEMESTER-X) PAPER-II
FUNCTIONAL ANALYSIS

Programme: M.Sc. (MATHEMATICS)	**Year: Fifth**	**Semester: 10th**
Subject: Mathematics		
Course Code: RB031002T	**Course Title: FUNCTIONAL ANALYSIS**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

FUNCTIONAL ANALYSIS

Unit	Topics	No. of Lectures
I	Normed linear spaces, Banach spaces, Examples and counter examples, Equivalent norms, Reisz Lemma, Basic properties of finite dimensional normed linear spaces, Bounded linear operators and functionals.	**15**
II	Dual spaces, Open mapping and closed graph theorems, Hahn-Banach theorem for real and complex linear spaces, Uniform boundedness theorem.	**15**
III	Hilbert spaces – Orthonormal sets, Bessel's inequality, complete orthonormal sets and Parseval's Identity, Structure of Hilbert spaces, Projection theorem, Riesz representation theorem.	**15**
IV	Adjoint of an operator on Hilbert space, Self-adjoint operators, Normal and unitary operators, Projections	**15**

Suggested Readings-

1. Goffan, C. and Pedrick, G.: A First course in Functional Analysis, AMS Chelsea Publishing: An Imprint of the American Mathematical Society, New York.
2. Jain, P.K. and Ahuja, O.P.: Functional Analysis, New Age (International P, Ltd,) New Delhi, 2010.
3. Kreyszig, E.: Introductory Functional Analysis with Applications, John Wiley and Sons, New York, 2007.
4. Simmons, G.F.: Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York, 2013.
5. Taylor, A.E. Introduction to Functional Analysis, John Wiley and Sons, New York, 2013.
6. Bollobas, B.: Linear Analysis, An Introductory Course, Cambridge University Press, Cambridge, 1999.
7. Berbarian, S.K.: Introduction to Hilbert Spaces, Oxford University Press, New York, 1961.

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**

M.Sc. (MATHS.) (SEMESTER-X) PAPER-III
OPERATIONS RESEARCH

Programme: **M.Sc. (MATHEMATICS)**	**Year: Fifth**	**Semester: 10th**
Subject: Mathematics		
Course Code: RB031003T	**Course Title: OPERATIONS RESEARCH**	
Credits: 4	**Core Compulsory**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

OPERATIONS RESEARCH

Unit	Topics	No. of Lectures
I	**INTRODUCTION:** Nature and Scope of Operations Research, Replacement Problem, Sequencing Problem, Integer Programming Problem, Dynamic Programming Problem.	15
II	**GAME THEORY:** Two Persons Zero Sum Game, Game with and Without Saddle Point, Dominance Rule, Approximation Method, Graphical Method, LPP Equivalent to Game Problem.	15
III	**NON-LINEAR PROGRAMMING PROBLEM**: Graphical Method, Constrained Optimization, Kuhn-Tucker Conditions, Quadratic Programming: Beale's Method and Wolfe's Method.	15
IV	**WAITING LINE PROBLEMS:** Steady State Solution of Queuing Models, Service System, Single Channel Models, Multiple Service Channels M/M/1, M/M/C Models. **NETWORK ANALYSIS**: Construction of the network diagram, Critical path – float and slack analysis, Total float, Free float, Independent float, Shortest-path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Project planning and control with PERT/CPM .	15

Suggested Readings-

1. Bertsekas, D.P. Nonlinear Programming, 2nd Edition., Athena Scientific, 1999.
2. Hadley, G.: Linear Programming, Narosa Publishing House, 1995.
3. Rao, S.S.: Optimization Theory and Applications (2nd Edition), New Age Int., New Delhi, 1995.
4. Swarup, K., Gupta, P.K. and Mohan Man: Operations Research (9th Edition), S. Chand and Sons, New Delhi, 2002.
5. Taha, H.A.; Operations Research: An Introduction (10th Edition), Pearson Publication, (2019)

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation/** Research Orientation assignment	5
4	**Assignment**	5

M.Sc. (MATHS.) (SEMESTER-X) PAPER-IV
SPECIAL FUNCTIONS

Programme: **M.Sc. (MATHEMATICS)**	**Year: Fifth**	**Semester: 10th**
Subject: Mathematics		
Course Code: RB031004T	**Course Title: SPECIAL FUNCTIONS**	
Credits: 4	**Core: Compulsory/ Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

SPECIAL FUNCTIONS

Unit	Topics	No. of Lectures
I	Orthogonal Sets of Functions, Chebyshev Polynomials.	15
II	Hypergeometric Functions: Pochhammer Symbol, Gauss Theorem, Vandermondes Theorem, Kummer's Theorem, Dixon Theorem.	15
III	Recall of Legendre's Polynomials and Bessel Functions, Associated Legendre's Function with their Properties.	15
IV	Hermite's Polynomials & Laguerre's Polynomials with their Properties	15

Suggested Readings-

1. SPECIAL FUNCTIONS BY M.D. RAISINGHANIA
2. SPECIAL FUNCTIONS BY GEORGE ANDREWS
3. SPECIAL FUNCTIONS BY W.W. BELL
4. SPECIAL FUNCTIONS AND THEIR APPLICATIONS BY N.N. LEBEDEV

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	10
2	**Online Quizzes/ Objective Tests**	5
3	**Presentation/** Research Orientation assignment	5
4	**Assignment**	5

M.Sc. (MATHS.) (SEMESTER-X) PAPER-V
MATHEMATICAL CRYPTOGRAPHY

Programme: **M.Sc. (MATHEMATICS)**	**Year: Fifth**	**Semester: 9th**
Subject: Mathematics		
Course Code: RB031005T	**Course Title:** MATHEMATICAL CRYPTOGRAPHY	
Credits: 4	**Core: Compulsory/ Elective**	
Max. Marks: 25+75	**Min. Passing Marks: 40 (With 30 mandatories in External Examination)**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

MATHEMATICAL CRYPTOGRAPHY

Unit	Topics	No. of Lectures
I	Division Algorithm, Euclidean Algorithm, Solution of Diophantine equations, Prime Numbers, Fundamental Theorem of Arithmetic, Properties of Congruence, Linear Congruence and Chinese Remainder Theorem, Complete and Reduced Residue systems, Fermat's theorem, Wilson's Theorem.	**15**
II	Euler's Phi Function, Euler's Theorem, Primitives roots and Indices, Quadratic Residues, Legendre symbol, Quadratic Reciprocity, Jacobi Symbol, Quadratic Congruence, Solution of Non- Linear Diophantine equations, Cybersecurity, Information security and Network security, Security Objectives, Security Attacks, Security Services, Security Mechanisms, Cryptography, Keyless Algorithms, Single-Key Algorithms, Two-Key Algorithms, Trust and Trustworthiness, Standards.	**15**
III	Plaintext, Ciphertext, Encryption, Decryption, Symmetric and Asymmetric Cipher Models, Cryptanalysis, Brute-Force Attack, Substitution and Transposition Techniques, Caesar (or Shift) Cipher, Monoalphabetic Ciphers, Playfair and Hill Ciphers, Polyalphabetic Ciphers, Vigenère Cipher, Vernam Cipher, One-Time Pad, Transposition Technique, Rail Fence, Stream and Block Ciphers, Feistel Cipher, DES and Example, Strength of DES, AES Structure.	**15**
IV	Public key cryptography, Hash functions, Discrete Logarithm Problem, Diffie-Hellmann key exchange, Elgamal Public Key Exchange, Collision Algorithm for DLP, Pohlig-Hellman Algorithm, RSA crypto-system, Digital Signatures, RSA signatures, Elgamal Digital Signatures and DSA, Elliptic Curve Cryptography, Lightweight and Post-Quantum Cryptography.	**15**

Suggested Readings-

1. David M. Burton, Elementary Number Theory 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. William Stallings, Cryptography and Network Security, Pearson India Education Services Pvt. Ltd.
3. Jeffrey Hoffstein, Jill Pipher and Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer New York, Second Edition.
4. Koblitz, N. A Course in Number Theory and Cryptography. 2nd edition Springer, 1994.
5. V. K. PACHGHARE, Cryptography and Information Security 3rd ed, Eastern Economy Edition, Delhi
6. Tilborg, H. C. A. Fundamentals of Cryptology. Springer, 2013.
7. Buchmann, J. A. Introduction to Cryptology, Springer Science & Business Media, 2012
8. Menezes, A. J., V., Oorschot, P. C. and Vanstone, S. A., Handbook of Applied Cryptography. CRC Press, 1996.
9. Simmons, G. J. Contemporary Cryptology, The Science of Information Integrity, New York, IEEE Press, 1992

Suggested Continuous Evaluation Methods: Max. Marks: 25

SN	Assessment Type	Max. Marks
1	**Class Tests**	**10**
2	**Online Quizzes/ Objective Tests**	**5**
3	**Presentation/** Research Orientation assignment	**5**
4	**Assignment**	**5**