Res No: AB/II(18-19).2.RUA13 / AC/II(18-19).2.RUS8

S.P.Mandali's
RAMNARAIN RUIA AUTONOMOUS COLLEGE, MUMBAI-19

RUIA COLLEGE
Explore • Experience • Excel

SYLLABUS FOR S.Y.B.Sc /S.Y.B.A

PROGRAM: B.Sc / B.A

COURSE: MATHEMATICS (RUSMAT/RUAMAT)

(Credit Based Semester and Grading System with effect from the academic year 2019–2020)

Semester III

Course Code	Unit	Topics	Credits	L/Week
Calculus III				
RUSMAT301	Unit I	Riemann Integration	3	3
	Unit II	Applications of Integration		
	Unit III	Improper Integrals		
Linear Algebra II				
RUSMAT 302, RUAMAT 301	Unit I	Linear Transformations and Matrices	3	3
	Unit II	Determinants		
	Unit III	Inner Product Spaces		
Discrete Mathematics				
RUSMAT303, RUAMAT302	Unit I	Preliminary Counting	3	3
	Unit II	Permutations and Recurrence Relations.		
	Unit III	Advanced Counting		

Semester IV

Course Code	Unit	Topics	Credits	L/Week
Calculus of Several Variables				
RUSMAT401	Unit I	Functions of Several Variables	3	3
	Unit II	Differentiation		
	Unit III	Applications		
Linear Algebra III				
RUSMAT402, RUAMAT401	Unit I	Quotient Spaces and Orthogonal Linear Transformations	3	3
	Unit II	Eigenvalues and Eigenvectors		
	Unit III	Diagonalization		
Ordinary Differential Equations				
RUSMAT403, RUAMAT402	Unit I	First order ordinary differential equations	3	3
	Unit II	Second order ordinary differential equations		
	Unit III	Power Series Solutions of Ordinary differential Equations		

S.Y.B.Sc Mathematics
Semester III

RUSMAT301 CALCULUS III

Learning Objectives:

1. To introduce notion of Riemann integration and improper integrals.

Learning Outcomes:

1. Learner will be able to identify Riemann Integrable functions.

2. Learner will be able to analyze applications of integration.

3. Learner will be able to test the convergence of improper integrals.

Detailed Syllabus:

Note: Review of $\liminf$ and $\limsup$.

Unit I: Riemann Integration(15 Lectures)

1. Approximation of area, Upper/Lower Riemann sums and properties, Upper/Lower integrals.
2. Concept of Riemann integration, criterion for Riemann integrability
3. Properties of Riemann integrable functions.
4. Basic results on Riemann integration.
5. Indefinite integrals and its basic properties.

Unit II: Applications of Integration (15 Lectures)

1. Average value of a function, Mean Value Theorem of Integral Calculus
2. Area between the two curves.
3. Arc length of a curve.
4. Surface area of surfaces of revolution
5. Volumes of solids of revolution, washer method and shell method.
6. Definition of the natural logarithm $\ln\_x$ as $\int_1^x \frac{1}{t}dt$, $x > 0$, basic properties.
7. Definition of the exponential function $\exp\_x$ as the inverse of $\ln\_x$, basic properties.
8. Power functions with fixed exponent or with fixed base, basic properties.

Unit III: : Improper Integrals (15 Lectures)

1. Definitions of two types of improper integrals, necessary and sufficient conditions for convergence.
2. Absolute convergence, comparison and limit comparison test for convergence. Abel's and Dirichlet's tests.
3. Gamma and Beta functions and their properties.

Reference Books:

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

(2) A. Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press, 2014.

(3) S. R. Ghorpade, B. V. Limaye, A Course in Calculus and Real Analysis, Springer International Ltd., 2000.

(4) T. M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pvt. Ltd.

(5) T. M. Apostol, Mathematical Analysis, Second Ed., Narosa, New Delhi, 1974.

(6) J. Stewart, Calculus, Third Ed., Brooks/Cole Publishing Company, 1994.

(7) R. Courant, F. John, Introduction to Calculus and Analysis, Vol I. Reprint of 1st Ed. Springer-Verlag, New York, 1999.

(8) M. H. Protter, Basic Elements of Real Analysis, Springer-Verlag, New York, 1998.

(9) G.B. Thomas, R. L. Finney, Calculus and Analytic Geometry, Ninth Ed.(ISE Reprint), Addison-Wesley, Reading Mass, 1998.

(10) R.G. Bartle, D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.

Suggested Tutorials:

(1) Calculation of upper sum, lower sum and Riemann integral.

(2) Problems on properties of Riemann integral.

(3) Sketching of regions in $\mathbb{R}^2$ and $\mathbb{R}^3$, graph of a function, level sets, conversions from one coordinate system to another.

(4) Applications to compute average value, area, volumes of solids of revolution, surface area of surfaces of revolution, moment, center of mass.

(5) Convergence of improper integrals, applications of comparison tests, Abel's and Dirichlet's tests, and functions.

(6) Problems on Gamma, Beta functions and properties

(RUSMAT302/RUAMAT301) LINEAR ALGEBRA II

Learning Objectives:

1. To introduce notion of dimensions of vector spaces and determinants.
2. Geometrical interpretation of the concept of determinants.
3. To introduce notion of inner product spaces.

Learning Outcomes:

1. Learner will be able to examine dimensions of vector spaces.
2. Learner will be able to explain the concept of determinants.
3. Learner will be able to apply the concept of determinants to geometry.
4. Learner will be able to identify inner product spaces.
5. Learner will be able to outline properties of inner products.

Detailed Syllabus:

Unit I: Linear Transformations and Matrices (15 Lectures)

1. Review of linear transformations, kernel and image of a linear transformation, Rank-Nullity theorem (with proof), linear isomorphisms, inverse of a linear isomorphism, any n-dimensional real vector space is isomorphic to $\mathbb{R}^n$.

2. The matrix units, row operations, elementary matrices and their properties.

3. Row Space, column space of $m \times n$ matrix, row rank and column rank of a matrix, equivalence of the row and column rank, Invariance of rank upon elementary row or column operations.

4. Equivalence of rank of an $m \times n$ matrix A and rank of the corresponding linear transformation, The dimension of solution space of the system of the linear equations $Ax = 0$

5. The solution of non-homogeneous system of linear equations represented by $Ax = b$, existence of a solution when $\operatorname{rank}(A) = \operatorname{rank}(A|b)$. The general solution of the system is the sum of a particular solution of the system and the solution of the associated homogeneous system.

Unit II: Determinants (15 Lectures)

1. Definition of determinant as an n-linear skew-symmetric function from $\mathbb{R}^n \times \mathbb{R}^n \times \cdots \times \mathbb{R}^n \to \mathbb{R}$ such that determinant of $(E^1, E^2, \ldots, E^n)$ is 1, where E^j denote the j^{th} column of the $n \times n$ identity matrix I_n.

2. Existence and uniqueness of determinant function via permutations, Computation of determinant of 2×2, 3×3 matrices, diagonal matrices, basic results on determinants such as $\det\_(A^t) = \det\_(A)$, $\det\_(AB) = \det\_(A)\det\_(B)$, Laplace expansion of a determinant, Vandermonde determinant, determinant of upper triangular matrices and lower triangular matrices.

3. Linear dependence and independence of vectors in $\mathbb{R}^n$ using determinants, the existence and uniqueness of the system $Ax = b$, where A is $n \times n$ matrix A, with $\det\_(A) \neq 0$, cofactors and minors, adjoint of an $n \times n$ matrix A, basic results such as $A.\operatorname{Adj}(A) = \det(A)I_n$. An $n \times n$ real matrix A is invertible if and only if $\det\_(A) \neq 0$, $A^{-1} = \frac{1}{\det\_(A)}\operatorname{Adj}(A)$ for an invertible matrix A, Cramer's rule.

Unit III: Inner Product Spaces (15 Lectures)

1. Dot product in $\mathbb{R}^n$, Definition of an inner product on a vector space over $\mathbb{R}$, examples of inner product

2. Norm of a vector Cauchy-Schwarz inequality, triangle inequality, orthogonality of vectors, Pythagorus theorem and geometric applications in $\mathbb{R}^2$, Projections on a line, the projection being the closest approximation, Orthogonal complements of a subspace, orthogonal complements in $\mathbb{R}^2$ and $\mathbb{R}^3$, orthogonal sets and orthonormal sets in an inner product space, orthogonal and orthonormal bases, Gram-Schmidt orthogonalization process, simple examples in $\mathbb{R}^3$, $\mathbb{R}^4$.

Reference Books:

(1) S. Lang, Introduction to Linear Algebra, Springer Verlag, 1997

(2) S. Kumarasen, Linear Algebra A geometric approach, Prentice Hall of India Private Ltd, 2000

(3) M. Artin, Algebra, Prentice Hall of India Private Ltd. 1991

(4) K. Hoffman, R.Kunze, Linear algebra, Tata McGraw-Hill, New Delhi. 1971

(5) G. Strang, Linear Algebra and its applications, International student Edition. 2016

(6) L. Smith, Linear Algebra and Springer Verlag. 1978

(7) A. R. Rao and P.BhimaSankaran, Linear Algebra, Tata McGraw-Hill, New Delhi. 2000

(8) T. Banchoff, J. Wermer, Linear Algebra through Geometry, Springer Verlag New York, 1984.

(9) S. Axler , Linear Algebra done right, Springer Verlag, New York, 2015

(10) K. Janich , Linear Algebra, Springer, 1994

(11) O. Bretcher, Linear Algebra with Applications, Prentice Hall, 1996

(12) G. Williams, Linear Algebra with Applications, Narosa Publication, 1984

(13) H. Anton, Elementary Linear Algebra, Wiley, 2014.

Suggested Tutorials:

(1) Rank-Nullity Theorem

(2) System of linear equations

(3) Determinants, calculating determinants of 2×2; 3×3 matrices, $n \times n$ diagonal, upper triangular matrices using Laplace expansion

(4) Finding inverses of 3×3 matrices using adjoint. Verifying $A.\mathrm{Adj}A = (\mathrm{Det}A)I_3$

(5) Examples of inner product spaces and orthogonal complements in $\mathbb{R}^2$ and $\mathbb{R}^3$.

(6) Gram-Schmidt method.

(RUSMAT303/RUAMAT302) DISCRETE MATHEMATICS

Learning Objectives:

1. To introduce notion of infinite sets and countability
2. To introduce notion of two way counting
3. To introduce notion of recurrence relations
4. to introduce notion of multisets.

Learning Outcomes:

1. Learner will be able to examine if given sets are countable.
2. Learner will be able to experiment with addition and multiplication principle.
3. Learner will be able to solve recurrence relations.
4. Learner will be able to extend notions of counting to multisets.

Detailed Syllabus:

Unit I: Preliminary Counting (15 Lectures)

1. Finite and infinite sets, countable and uncountable sets, examples such as $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{N} \times \mathbb{N}$, $\mathbb{Q}$, $(0, 1)$, $\mathbb{R}$
2. Addition and multiplication principle, counting sets of pairs,two way counting, Permutation and Combination of sets.
3. Pigeonhole principle and its applications.

Unit II: Permutations and Recurrence relation (15 Lectures)

1. Permutation of objects, S_n composition of permutations, results such as every permutation is product of disjoint cycles, every cycle is product of transpositions, even and odd permutations, rank and signature of permutation, cardinality S_n, A_n.
2. Recurrence relation, definition of homogeneous, non-homogeneous, linear and non linear recurrence relation, obtaining recurrence relation in counting problems, solving (homogeneous as well as non homogeneous) recurrence relation by using iterative method, solving a homogeneous relation of second degree using algebraic method proving the necessary result.

Unit III: Advanced Counting (15 Lectures)

1. Binomial and Multinomial Theorem, Pascal identity, examples of standard identities such as the following
   - $\sum_{k=0}^{r} \binom{m}{k}\binom{n}{r-k} = \binom{m+n}{r}$
   - $\sum_{i=r}^{n} \binom{i}{r} = \binom{n+1}{r+1}$
   - $\sum_{i=0}^{k} \binom{k}{i}^2 = \binom{2k}{k}$
   - $\sum_{i=0}^{n} \binom{n}{i} = 2^n$
2. Permutations and combinations of multi-sets, circular permutations, emphasis on solving problems.

3. Non-negative and positive integral solutions of the equation $x_1+x_2+\cdots+x_r = n$.

4. Principle of Inclusion and Exclusion, its applications, derangements, explicit formulae for d_n, various identities involving d_n, deriving formula for Euler's phi function $\phi(n)$

Reference Books:

(1) N. Biggs, Discrete Mathematics, Oxford University Press, 1985

(2) R. Brualdi, Introductory Combinatorics, Pearson, 2010.

(3) V. Krishnamurthy, Combinatorics-Theory and Applications, Affiliated East West Press, 1985

(4) A. Tucker, Applied Combinatorics, John Wiley and Sons,1980

(5) S. S. Sane, Combinatorial Techniques, Hindustan Book Agency, 2013.

Suggested Practicals (Tutorials for B.A.):

(1) Problems based on counting principles, two way counting.

(2) Pigeonhole principle.

(3) Signature of a permutation. Expressing permutation as the product of disjoint cycles. Inverse of a permutation

(4) Recurrence relation.

(5) Multinomial theorem, identities, permutations and combinations of multisets.

(6) Inclusion-Exclusion principle, Derangements, Euler's phi function.

SEMESTER IV

(RUSMAT401) CALCULUS OF SEVERAL VARIABLES

Learning Objectives:

1. To introduce notion of real valued functions of several variables.
2. Surfaces and curves as real valued functions of several real variables.
3. To introduce diffrentability of real valued functions of several variables.

Learning Outcomes:

1. Learner will be able to compare properties of functions of several variables with those of functions of one variable.
2. Learner will be able to deduce geometrical properties of surfaces and lines.
3. Learner will be able to apply the concept of differentiability to other sciences.

Detailed Syllabus:

Unit I: Functions of several variables (15 Lectures)

1. Euclidean space, $\mathbb{R}^n$- norm, inner product, distance between two points, open ball in $\mathbb{R}^n$, definition of an open set / neighbourhood, sequences in $\mathbb{R}^n$, convergence of sequences (these concepts should be specifically discussed for $n = 2$ and $n = 3$).

2. Functions from $\mathbb{R}^n \to \mathbb{R}$ (scalar fields) and from $\mathbb{R}^n \to \mathbb{R}^n$ (Vector fields), sketching of regions in $\mathbb{R}^2$ and $\mathbb{R}^3$. Graph of a function, level sets, cartesian coordinates, polar coordinates, spherical coordinates, cylindrical coordinates and conversions from one coordinate system to other. Iterated limits, limits and continuity of functions, basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity of components of vector fields.

3. Directional derivatives and partial derivatives of scalar fields.

4. Mean value theorem for derivatives of scalar fields.

Unit II: Differentiation (15 Lectures)

1. Differentiability of a scalar field at a point (in terms of linear transformation) and in an open set, total derivative, uniqueness of total derivative of a differentiable function at a point, basic results on continuity, differentiability, partial derivative and directional derivative.

2. Gradient of a scalar field, geometric properties of gradient, level sets and tangent planes.

3. Chain rule for scalar fields.

4. Higher order partial derivatives, mixed partial derivatives, sufficient condition for equality of mixed partial derivative.

Unit III: Applications (15 Lectures)

1. Second order Taylor's formula for scalar fields.

2. Differentiability of vector fields, definition of differentiability of a vector field at a point Jacobian and Hessian matrix, differentiability of a vector field at a point implies continuity, the chain rule for derivative of vector fields (statement only).

3. Mean value inequality.

4. Maxima, minima and saddle points.

5. Second derivative test for extrema of functions of two variables.

6. Method of Lagrange multipliers.

Reference Books:

(1) S. R. Ghorpade, B. V. Limaye, A Course in Multivariable Calculus and Analysis, Springer, 2010.

(2) T. Apostol, Calculus, Vol. 2, John Wiley, 1969.

(3) J. Stewart, Calculus, Brooke/Cole Publishing Co., 1994.

Suggested Tutorials:

(1) Sequences in $\mathbb{R}^2$ and $\mathbb{R}^3$, limits and continuity of scalar fields and vector fields, using definition and otherwise, iterated limits.

(2) Computing directional derivatives, partial derivatives and mean value theorem of scalar fields.

(3) Total derivative, gradient, level sets and tangent planes.

(4) Chain rule, higher order derivatives and mixed partial derivatives of scalar fields.

(5) Taylor's formula, differentiation of a vector field at a point, finding Jacobian and Hessian matrix, Mean value inequality.

(6) Finding maxima, minima and saddle points, second derivative test for extrema of functions of two variables and method of Lagrange multipliers.

(RUSMAT402 / RUAMAT401) Linear Algebra III

Learning Objectives:

1. To introduce notion of quotient structures.
2. To introduce geometrical aspects of eigenvalues and eigenvectors of linear transformations and matrices.

Learning Outcomes:

1. Learner will be able to explain quotient structures on vector spaces.
2. Learner will be able to explain the concepts of orthogonalization.
3. Learner will be able to apply the concepts of eigenvalues and eigenvectors to geometry.

Detailed Syllabus:

Unit I: Quotient Spaces and Orthogonal Linear Transformations (15 Lectures)

(1) Review of vector spaces over $\mathbb{R}$, subspaces and linear transformations.

(2) Quotient spaces, first isomorphism theorem of real vector spaces (fundamental theorem of homomorphism of vector spaces), dimension and basis of the quotient space V/W, where V is finite dimensional vector space and W is subspace of V.

(3) Orthogonal transformations, isometries of a real finite dimensional inner product space, translations and reflections with respect to a hyperplane, orthogonal matrices over $\mathbb{R}$, equivalence of orthogonal transformations and isometries fixing origin on a finite dimensional inner product space, orthogonal transformation of $\mathbb{R}$, any orthogonal transformation in $\mathbb{R}$ is a reflection or a rotation, characterization of isometries as composites of orthogonal transformations and translation.

(4) Characteristic polynomial of an $n \times n$ real matrix, Cayley Hamilton theorem and its applications (Proof assuming the result: $A\,\mathrm{Adj}(A) = \det(A)I_n$ for an $n \times n$ matrix A over the polynomial ring $\mathbb{R}[t]$).

Unit II: Eigenvalues and eigen vectors (15 Lectures)

(1) Eigen values and eigen vectors of a linear transformation $T : V \to V$ where V is a finite dimensional real vector space and examples, Eigen values and Eigen vectors of $n \times n$ real matrices, linear independence of eigenvectors corresponding to distinct eigenvalues of a linear transformation and a matrix.

(2) The characteristic polynomial of a $n \times n$ real matrix and a linear transformation of a finite dimensional real vector space to itself, characteristic roots, similar matrices, relation with change of basis, invariance of the characteristic polynomial and eigen values of similar matrices, every $n \times n$ square matrix with real eigenvalues is similar to an upper triangular matrix.

(3) Minimal Polynomial of a matrix, examples, diagonal matrix, similar matrix, invariant subspaces.

Unit III: Diagonalisation (15 Lectures)

(1) Geometric multiplicity and algebraic multiplicity of eigen values of an $n \times n$ real matrix, equivalent statements about diagonalizable matrix and multiplicities of its eigenvalues , examples of non diagonalizable matrices,

(2) Diagonalisation of a linear transformation $T : V \to V$ where V is a finite dimensional real vector space and examples.

(3) Orthogonal diagonalisation and quadratic forms, diagonalisation of real symmetric matrices, examples, applications to real quadratic forms, rank and signature of a real quadratic form

(4) Classification of conics in $\mathbb{R}^2$ and quadric surfaces in $\mathbb{R}^3$, positive definite and semi definite matrices, characterization of positive definite matrices in terms of principal minors.

Reference Books:

(1) S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice Hall of India, 2000

(2) R. Rao, P. Bhimasankaram, Linear Algebra, TRIM, Hindustan Book Agency, 2000.

(3) T. Banchoff, J. Wermer, Linear Algebra through Geometry, Springer, 1992.

(4) L. Smith, Linear Algebra, Springer, 1978.

(6) K Hoffman, Kunze, Linear Algebra, Prentice Hall of India, New Delhi, 1971.

Suggested Tutorials:

(1) Quotient spaces, orthogonal transformations.

(2) Cayley Hamilton theorem and applications.

(3) Eigenvalues and eigenvectors of a linear transformation and a square matrix.

(4) Similar matrices, minimal polynomial.

(5) Diagonalization of a matrix.

(6) Orthogonal diagonalization and quadratic forms.

(RUSMAT403/ RUAMAT402) ORDINARY DIFFERENTIAL EQUATIONS

Learning Objectives:

1. To introduce notion of ordinary differential equations
2. To introduce simple methods to solve ODE
3. To introduce simple applications of ODE

Learning Outcomes:

1. Learner will be able to classify the ODE according to degree and order of ODE.
2. Learner will be able to solve an ODE.
3. Learner will be able to apply the concepts of ODE to biological sciences and physics.

Detailed Syllabus:

Unit I: First order First degree Differential equations (15 Lectures)

(1) Definition of a differential equation, order, degree, ordinary differential equation, linear and non linear ODE.

(2) Existence and Uniqueness Theorem for the solutions of a second order initial value problem (statement only), Lipschitz function, examples

(3) Review of solution of homogeneous and non- homogeneous differential equations of first order and first degree, notion of partial derivative, exact equations, general solution of exact equations of first order and first degree, necessary and sufficient condition for $Mdx + Ndy = 0$ to be exact, non-exact equations, rules for finding integrating factors (without proof) for non exact equations and examples

(4) Linear and reducible to linear equations, applications of first order ordinary differential equations.

Unit II: Second order Linear Differential equations (15 Lectures)

(1) Homogeneous and non-homogeneous second order linear differentiable equations, the space of solutions of the homogeneous equation as a vector space, wronskian and linear independence of the solutions, the general solution of homogeneous differential equation, the use of known solutions to find the general solution of homogeneous equations, the general solution of a non-homogeneous second order equation, complementary functions and particular integrals.

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

(3) Non-homogeneous equations, the method of undetermined coefficients, the method of variation of parameters.

Unit III: Power Series solution of ordinary differential equations (15 Lectures)

1. A review of power series.
2. Power series solutions of first order ordinary differential equations.
3. Regular singular points of second order ordinary differential equations.
4. Frobenius series solution of second order ordinary differential equations with regular singular points.

Reference Books:

(1) G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 1972.

(2) E. A. Coddington , An Introduction to Ordinary Differential Equations. Prentice Hall, 1961.

(3) W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiely, 2013.

(4) D. A. Murray, Introductory Course in Differential Equations, Longmans, Green and Co., 1897.

(5) A. R. Forsyth, A Treatise on Differential Equations, MacMillan and Co., 1956.

Suggested Practicals for S.Y.B.Sc. and Tutorial for S.Y.B.A.:

1) Application of existence and uniqueness theorem, solving exact and non exact equations.
2) Linear and reducible to linear equations, applications to orthogonal trajectories, pop-ulation growth, and finding the current at a given time.
3) Finding general solution of homogeneous and non-homogeneous equations, use of known solutions to find the general solution of homogeneous equations.
4) Solving equations using method of undetermined coefficients and method of variation of parameters.
5) Power series solutions of first order ordinary differential equations.
6) Frobenius series method for second order ordinary differential equatuions.

MODALITY OF ASSESSMENT

Theory Examination Pattern:
A) Internal Assessment - 40% :
(Except for RUSMAT303/RUAMAT302 and RUSMAT403/RUAMAT402)

Total: 40 marks.
1 One Assignment/Case study/Project/ seminars/presentation: 10 marks
2 One class Test (multiple choice questions / objective) 20 marks
3 Active participation in routine class instructional deliveries and Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc. 10 marks

B) External examination - 60 %
Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of 2 hours duration.

ii. Paper Pattern:

1. There shall be 3 questions each of 20 marks. On each unit there will be one question.
2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)A)	Any 1 out of 2	08	Unit I
Q.1)B)	Any 2 out of 4	12	
Q.2)A)	Any 1 out of 2	08	Unit II
Q.2)B)	Any 2 out of 4	12	
Q.3)A)	Any 1 out of 2	08	Unit III
Q.3)B)	Any 2 out of 4	12	

Practical Examination Pattern:
(For RUSMAT303/RUAMAT302 and RUSMAT403/RUAMAT402)

Journal 05 marks
Viva 05 marks
Test 30 marks
Total 40 marks