VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Mathematics

SYLLABUS

Master of Science/Social Science/Arts/etc…
(I-IV Semester)

With effect from
2021-22

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

II-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
SECOND	DSC6	21MAT2C6L	Linear Algebra	30	70	100	4	-	-	4	3
	DSC7	21MAT2C7L	Measure theory and Integration	30	70	100	4	-	-	4	3
	DSC8	21MAT2C8L	Fluid Mechanics	30	70	100	4	-	-	4	3
	DSC9	21MAT2C9L	Differential Geometry	30	70	100	4	-	-	4	3
	DSC10	21MAT2C10L	Complex Analysis	30	70	100	4	-	-	4	3
	SEC2	21MAT2S2LP	R-Programming	20	30	50	1	-	2	2	1
	DSC6P2	21MAT2C6P	Linear Algebra using MATLAB	20	30	50	-	-	4	2	4
Total Marks for II Semester						**600**				**24**	

Dept Name: Mathematics
Semester-II
DSC6: Linear Algebra

Course Title: Linear Algebra	Course code: 21MAT2C6L
Total Contact Hours: 52	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

13. Write clear and precise proofs for theorems needed to construct bases for vector spaces.
14. Ability to implement the Gram-Schmidt procedure to construct orthogonal basis.
15. Gaining of knowledge between matrices and linear transformations.
16. Determination of Jordan form for given a matrix.
17. Ability to compute the exponential of matrix.

DSC6: Linear Algebra

Unit	Description	Hours
1	Row- reduced Echelon matrices, Vector spaces, Sub spaces, Linear span, Linear independence, dependence and their basic properties. Basis of a vector space. Some results on the construction of basis. Dimension of a space. Coordinate matrix of a vector and its properties. Sums of subspaces. Quotient space and its dimension. Existence theorem for basis of a vector space.	11
2	Linear transformation and its properties. Singular and non-singular linear transformations. Rank and nullity theorem. Isomorphism results on finite dimensional vector space. Representation of transformation by a matrix. Change of basis. Similar matrices. Similarity of linear transformations. Problems related to similarity.	11
3	Linear functional and dual spaces. Dual basis. Second dual spaces, natural mapping and reflexivity. Transpose of a linear map. Anhilator of a subspace. Four fundamental subspaces of a matrix.	10
4	Inner Product Spaces. Examples on inner product spaces of finite and infinite dimensional spaces. Schwarz's inequality. Orthonormal basis, Gram-Schmidt orthogonalization process. Orthogonal complement. Some results on Best approximation. Bessel's Inequality.	10
5	Eigenvalues and Eigenvectors of a linear transformations. Cayley-Hamilton Theorem. Minimal polynomial, diagonal form, Jordan form. Exponential of a matrix and its application to linear system of differential equations.	10

References:

1. K. Hoffman and R. Kunze, Linear Algebra, PHI,
2. K. P. Gupta, Linear Algebra, Pragati Prakashan,Nineteeth revised edition, 2016.

3. N. Jacobson : Basic Algebra-I, HPC, 1984.
4. I.N. Herstein : Topics in Algebra, 2nd Edition, Vikas Publishing House, 1976.
5. Gilbert Strang, Linear Algebra and its applications, Pearson,Fourth Edition,2007.

Date　　Course Coordinator　　Subject Committee Chairperson

DSC7: Measure Theory and Integration

Course Title: Measure Theory and Integration	Course code: 21MAT2C7L
Total Contact Hours: 52	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Extend the concepts of Riemann integral.The concepts of vector valued functions and Rectifiable curves are introduced.
2. Differentiate and Integrate Complex functions.
3. Carry out Stone Weierstrass theorem.
4. Compute sequence and series of functions.
5. Apply techniques of measurable functions in varies fields.
6. To state some of the classical theorems in of Advanced Real Analysis.
7. Know about the concepts of functions of bounded variations and the absolute continuity of functions with their relations.

DSC7: Measure Theory and Integration

Unit	Description	Hours
1	Sigma algebras, open subsets of the real line.F_σ and G_δ sets, Borel sets, Outer measure of a subset of R ' Lebesgue outer measure of a subset of R Existence, non-negativity and monotonicity of Lebesgue outer measure; Relation between Lebesgue outer measure and length of an interval; Countable subadditivity of Lebesgue outer measure; translation invariance.(Lebesgue) measurable sets, (Lebesgue) measure; Complement, union, intersection and difference of measurable sets; denumerable union and intersection of measurable sets; countable additivity of measure; The class of measurable sets as a algebra, the measure of the inter section of a decreasing sequence of measurable sets.	11
2	Measurable functions; Scalar multiple, sum, difference and product of measurable functions.Measurability of a continuous function and measurability of a continuous image of measurable function.Convergence pointwise and convergence in measures of a sequence of measurable functions.	11
3	Lebesgue Integral; Characteristic function of a set; simple function; Lebesgue integral of a simple function; Lebesgue integral of a bounded measurable function; Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function; Properties	10

	of Lebesgue integral.	
4	Convergence Theorems and Lebesgue integral; The bounded convergence theorem; Fatou's Lemma: Monotone convergence theorem; Lebesgue convergence theorem. Differentiation of Monotone functions. Vitali covering lemma. Functions of Bounded variation. Differentiability of an integral. Absolute continuity and indefinite integrals.	10
5	L_p speace. Signed measure : positive and negative sets and theorems Hahn Decomosition theorem signed measures. Random Nikodym theorems Product measure. Fubinis theorem.	10

References:

1. H. L. Royden : Real Analysis, Pearson Publication, 2017.
2. P.R. Halmos : Measure Theory, Springer, 2008.
3. W. Rudin. Real & Complex Analysis, Tata McGraw Hill Publishing Company Ltd, 2007.
4. I. K. Rana. An introduction to measure and integration, Narosa publishing House, 2007.
5. K. P. Gupta and Gupta. Measure and Integration, Krishna Prakashan Media (P) Ltd, II, Shivaji Road, Meerut (U.P) India, 2020.
6. A. K. Mallik, S. K. Gupta, S. R. Singh, S. C. Mallik. Measure Theory and Integration, Wiley India Pvt Ltd, 2020.
7. Debarra G. Measure Theory and Integration, New Age Publication, 2013.

Date Course Coordinator Subject Committee Chairperson

DSC8: Fluid Mechanics

Course Title: Fluid Mechanics	Course code: 21MAT2C8L
Total Contact Hours: 52	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. State the Newton's law of viscosity and explain the mechanics of fluids at rest and in motion by observing the fluid phenomena.
2. Determine Stream function and its physical significance.
3. Derive Euler's Equation of motion and Deduce Bernoulli's equation.
4. Examine energy losses in pipe transitions and sketch energy gradient lines.
5. Derive Stokes theorem, Kelvins circulation theorem, Greens theorem.

DSC8: Fluid Mechanics

Unit	Description	Hours
1	Introduction, Some basic properties of fluid, Viscous and invicid fluids, Viscosity, Newtonian and non-Newtonian fluids, Real and ideal fluids, Some important types of flows. Kinematics of fluid motion: Lagarangian method, Eulerian method, velocity, acceleration of a fluid particle, material , local and convective derivatives and illustrative examples. The equation of continuity in different co ordinates, some symmetrical forms of the equation of continuity. Illustrative through examples.	12
2	Equations of motion of inviscid fluids: Stream line, path line ,streak line ,velocity potential, vortex line , vortex tube , vortex filament, and illustrative examples. Eulers equation of motion in Cartesian form (polar and spherical form notations only), Equation of motion under impulsive forces and illustration through applications.	10
3	The energy equation and illustrative through applications, Lagaranges hydrodynamical equations, Cauchy's integrals, Helmholtz vorticity equations. Bernoulli's equation and theorem: illustrative with applications.	9
4	Motion in Two dimensions: Stream function and the physical significance, complex potential, Cauchy Reimann equation in polar form, complex potential for uniform flows: illustrative through examples.	9
5	Source and sinks in two dimensions, complex potential due to a source, doublet in two dimensions and illustrative through examples. Images and its advantages, Image of a source with respect to a line and image of a doublet with respect to a line. General theory of ir-rotational Motion: Introduction, Flow and circulation, Stokes theorem, Kelvins circulation theorem, performance of irrotational motion, Greens theorem, deductions from Greens theorem.	12
References:		

1. Text Book on Fluid Dynamics, CBS Publishers, F Chorlton, 2018.
2. Fluid Mechanics McGraw Hill Book Company, Walther Kaufmann , 1958.
3. An Introduction to Fluid Dynamics, Cambridge University press, G K Batchelor2009.
4. Fluid Dynamics S Chand Publisher, 2nd Edition, M D Raisinghania, 2020.
5. Viscous Fluid Dynamics, Oxford and IBH Publishers, J L Bansal2004
6. Vectors, Tensors and the Basic equations of Fluid Mechanics, Dover Publishers, R Aris, 1990.
7. A text Book of Fluid Mechanics and Hydraulic Mechanics, Laxmi Publications, R K Bansal,2018.
8. Fluid Dynamics Krishna Publishers, Shanthi Swaroop, 2020.
9. Fluid Mechanics, Khanna Publishers, Jain A K, 2998.

Date Course Coordinator Subject Committee Chairperson

DSC9: Differential Geometry

Course Title: Differential Geometry	Course code: 21MAT2C9L
Total Contact Hours: 52	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Understand the fundamental theorems on plane curves.
2. Define and understand space curves with the help of examples.
3. Compute the curvature and torsion of space curves.
4. Understand geometry of Surfaces.
5. Compute the directional derivatives of functions on a surface of E^3.

DSC9: Differential Geometry

Unit	Description	Hours
1	**Calculus on Euclidean Space:** Euclidean space. Natural coordinate functions. Differentiable functions. Tangent vectors and tangent spaces. Vector fields. Directional derivatives and their properties. Curves in E^3.Velocity and speed of a curve. Reparametrization of a curve. 1-forms and Differential forms. Wedge product of forms. Mappings of Euclidean spaces, Derivative map.	10
2	**Frame Fields:** Vector field along a curve. Tangent vector field, Normal vector field and Binormal vector field. Curvature and torsion of a curve.T he Frenet formulas, Frenet approximation of unit speed curve and Geometrical interpretation. Properties of plane curves and spherical curves. Isometries of E^3 - Translation, Rotation and Orthogonal transformation. The derivative map of an isometry.	10
3	**Calculus on a Surface:** Coordinate path. Monge path. Surface in E^3.Special surfaces-sphere, cylinder and surface of revolution. Parameter curves, velocity vectors of parameter curves, Patch computation. Parametrization of surfaces-cylinder, surface of revolution and torus. Tangent vectors, vector fields and curves on a surface in E^3. Directional derivative of a function on a surface of E^3. Differential forms and exterior derivative of forms on surface of E^3. Pull back functions on surfaces of E^3.	11
4	**Shape Operators:** Definition of shape operator. Shape operators of sphere, plane, cylinder and saddle surface. Normal curvature, Normal section.Principal curvature and principal direction. Umbilic points of a surface in E^3. Euler's formula for normal curvature of a surface in E^3.	11
5	**Geometry of Surfaces in $\mathbf{R^3}$:** The Fundamental Equations, Form Computations, Some Global Theorems, Isometries and Local Isometries, Intrinsic Geometry of Surfaces in R^3, Orthogonal Coordinates, Integration and Orientation, Total Curvature, Congruence of Surfaces.	10

References:

1. Barrett O' Neil : Elementary Differential Geometry. Revised Second Edition, Academic Press, New York and London, 2006.
2. T.J.Willmore : An introduction to Differential Geometry. Dover Publications, 2013.
3. D.J.Struik : Lectures on Classical Differential Geometry, Second edition, Addison Wesley, Reading, Massachusetts, 1961.
4. Nirmala Prakassh: Differential Geometry- an integrated approach. Tata McGraw-Hill, New Delhi, 1981.

Date Course Coordinator Subject Committee Chairperson

DSC10: Complex Analysis

Course Title: Complex Analysis	Course code: 21MAT2C10L
Total Contact Hours: 52	Course Credits: 04
Formative Assessment Marks: 30	Duration of ESA/Exam: 3 hours
Summative Assessment Marks: 70	

Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Represent complex numbers algebraically and geometrically.
2. Evaluate complex contour integrals and apply the Cauchy integral theorem in its various versions and Cauchy integral formula.
3. Students realize calculus of residues as one of the power tools in solving some problems, like improper and definite integrals effortlessly.

DSC10: Complex Analysis

Unit	Description	Hours
1	Analytic functions, Harmonic conjugates, Elementary functions, Mobius Transformation, Conformal mappings, Cauchy' s Theorem and Integral formula, Morera' s Theorem, Cauchy' s Theorem for triangle, Cauchy's Theorem in a disk, Zeros of Analytic function. The index of a closed curve, counting of zeros.Principles of analytic Continuation.Liouville' s Theorem, Fundaments theorem of algebra.	12
2	Series, Uniform convergence, Power series, Radius of convergences, Power series representation of Analytic function, Relation between Power series and Analytic function, Taylor' s series, Laurent' s series.	10
3	Rational Functions, Singularities, Poles, Classification of Singularities, Charecterisation of removable Singularities, poles, .Behaviour of an Analytic functions at an essential singular point. Entire and Meromorphicfunctions. The Residue Theorem.	10
4	Evaluation of Definite integrals, Argument principle, Rouche' s Theorem, Schwartz lemma, Open mapping and Maximum modulus theorem and applications.	9
5	Convex functions, Hadmard's Three circle theorem. Phragmen-Lindelof theorem Harmonic functions – Basic properties – Polar form – Mean value property – Poisson's formula – Schwartz's theorem.	11

References:

1. J. B. Conway. Functions of one complex variable, Narosa Publication, 1987
2. L.V. Ahlfors, Complex Analysis, McGraw Hill, 1986.
3. J. W. Brown & R. V. Churchill. Complex Variables and Applications, McGraw Hill, 2017.
4. Kasana. Complex Variables, Prentice Hall, 2015.
5. S. Ponnaswamy, Foundations of Complex Analysis, Narosa Publications, 2011.
6. S Kumarasan, A Pathway to Complex Analysis, Techno World, 2021.

Date Course Coordinator Subject Committee Chairperson

SEC 2: R-Programming

Course Title: R-Programming	Course code: 21MAT2S2TP
Total Contact Hours: 39	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 1 hour
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Understand the basics in R programming in terms of constructs, control statements, string functions.
2. Understand the use of R for Big Data analytics.
3. Learn to apply R programming for Text processing.
4. Able to appreciate and apply the R programming from a statistical perspective.

SEC 2: R-Programming

Unit	Description	Hours
1	Introduction: Basic fundamentals, installation and use of R software, Creation of new variables, vectors, matrices, data frames, lists, accessing elements of a vector or matrix, import and export of files, for loop, repeat loop, while loop, if command, if else command, R-functions.	7
2	The plot command, histogram, bar-plot, box-plot, points, lines, segments, arrows, inserting mathematical symbols in a plot, pie diagram, customization of plot setting, graphical parameters, adding text, saving to a file, adding a legend.	6
3	List of Programs: 1. Find the addition and subtraction of two matrices. 2. Find the product of two matrices. 3. Find the inverse of the matrix. 4. Check the given number is prime of not. 5. Print the Fibonacci sequence. 6. Find the sum of two vectors. 7. Find the product of two vectors. 8. Write R codes that takes the coefficients of a quadratic equation, and outputs an appropriate message for the cases of (i). two distinct roots $b^2 - 4ac > 0$ (ii) coincident roots $b^2 - 4ac = 0$ or (iii). complex roots $b^2 - 4ac < 0$ 9. From the pre-summarized data note column and row names. Make the columns of the object available by name. Construct plots. Add axes label and legends. 10. From the pre-summarized data in a table draw bar plot and histogram plot. Add axes label and legends.	26

References (indicative)

1. Zuur, A.F., Leno, E.N. &Meesters, A Beginner's Guide to R. Springer, E.H.W.G. 2010.
2. Mark Gardener, Beginning R – The Statistical Programming Language, Wiley, 2013.
3. R for Beginners, Emmanuel Paradis. https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf
4. The Book of R: A First Course in Programming and Statistics, Tilman M. Davies, No Starch Press, Inc. https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf
5. https://www.tutorialspoint.com/r/r_tutorial.pdf
6. Using R for Numerical Analysis in Science and Engineering, Victor A. Bloomfield, A Chapman & Hall Book. http://hsrm-mathematik.de/SS2020 /semester4 / Datenanalyse-und-Scientific Computing-mit-R/book.pdf
7. Robert Knell, Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R, Amazon Digital South Asia Services Inc, 2013
8. The R Software-Fundamentals of Programming and Statistical Analysis -Pierre Lafaye de Micheaux, Rémy Drouilhet, Benoit Liquet, Springer 2013.

Date　　　　Course Coordinator　　　　Subject Committee Chairperson

DSC6P2: Linear Algebra using MATLAB

Course Title: Linear Algebra using MATLAB	Course code: 21MAT2C6P
Total Contact Hours: 52	Course Credits: 02
Formative Assessment Marks: 20	Duration of ESA/Exam: 4 hours
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Verify the important results learnt in linear algebra on their own with the help of platform matlab.
2. Compute matrices related activities using Matlab.
3. Take up challenging job of scientific computing with Matlab.
4. Solve some standard system ODE of higher order.

DSC6P2: Linear Algebra using MATLAB

Unit	Description	Hours
1	List of Programs: 1. Find the angle between two vectors in n-dim space and check the orthogonality. 2. Find the rank and nullity of a matrix through its row reduced echelon form. 3. Test whether or not vector v is in the span of a set of vectors. 4. Discuss the nature of consistency for system of linear equations. 5. Check the linear dependency of set of vectors. 6. Determine whether or not the system of linear equations Ax=b, where A=ones(3,2) b=[1;2;3]; possesses an exact solution x. 7. Compute and print the basis and dimension of each four fundamental subspaces associated with a matrix. 8. Find the coordinate matrix of a vector in a vector space of dimension 4 with respect to some basis. 9. Check a given vector orthogonal to column space of a given matrix. 10. Compute the transition matrix from one vector space to another vector space. 11. Compute some parameters of a matrix using its eigenvalues and eigenvectors such as trace, determinant and condition number, algebraic multiplicity etc. 12. Read set of vectors in a Euclidean space and check the nature of orthogonality. 13. Write a function to illustrate Gram-Schmidt orthogonalization process in a Euclidean space of dimension 4. 14. Verify the Bessel's inequality. 15. Compute some polynomials and canonical forms associated with a given matrix. 16. Solve simple system of ordinary differential equations using exponential matrix. 17. Construct a Vandermonde matrix , Toeplitz matrix, Hilbert matrix and find their traces.	52

	18. Read a matrix A. Determine whether or not the matrix A is diagonalizable. If so, find a diagonal matrix D that is similar to A. 19. Fit a cubic polynomial for sin(2t) over [0, pi/2]. 20. Let A be a real matrix. Use MATLAB function rref to extract all (a) columns of A that are linearly independent (b) rows of A that are linearly independent.	

References (indicative)

1. D.R. Hill and D.E. Zitarelli, Linear Algebra Labs with MATLAB, 2nd edition, Prentice.
2. Hall, Upper Saddle River, NJ, 1996.
3. Gilbert Strang, Linear Algebra and its applications,4th edition, Thomson,2006.

Date Course Coordinator Subject Committee Chairperson

CBCS Question Paper Pattern for PG Semester End Examination

with Effect from the AY 2021-22

Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)

Paper Code: **Paper Title:**

Time: 3 Hours **Max. Marks: 70**

Note: Answer any *FIVE* of the following questions with Question No. 1 (Q1) Compulsory, each question carries equal marks.

Q1. 14 Marks

Q2. 14 Marks

Q3. 14 Marks

Q4. 14 Marks

Q5. 14 Marks

Note: Question No.1 to 5, *one question from each unit* i.e. (Unit I, Unit II, ….). The Questions may be a whole or it may consists of sub questions such as a,b, c etc…

Q6. 14 Marks

Note :Question No.6, *shall be from Unit II and III,* the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q7. 14 Marks

Note: Question No.7*, shall be from Unit IV and V*,the Question may be a whole or it may consists of sub questions such as a,b, c etc…

Q8. 14 Marks

Note: Question No-8 shall be from *Unit II, Unit III , Unit IV and Unit V*. The question shall have the following sub questions and weightage. i.e a – 05 marks, b – 05 marks, c – 04 marks.

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Skill Enhancement Courses (SECs)

Paper Code: **Paper Title:**

Time: 1 Hours **Max. Marks: 30**

There shall be Theory examinations of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

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