

Education	Department of Basic and Applied Science NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH (ESTABLISHED BY MINISTRY OF EDUCATION, GOVT. OF INDIA)	Ethics
In GOD's own land, a fusion of scholastic students, innovative & motivated researchers & teachers and fast moving visionary leaders.	 Course Structure & Syllabus For M.Sc. in Data Science (2 Years)	Steeping Stone and Sky reaching ladder to success
Research	Jote, Dist: Papum Pare, Arunachal Pradesh, Pin-791113, India Ph. No: 0360-2284801/2001582 Fax No: 0360-2284972 www.nitap.ac.in	Service to Society

Program Objective:

- To understand and learn the core principles of Mathematics in Data Science
- To nurture the coding skills for Data Science
- To learn the physical and analytical significance of the problems to be solved
- To learn subjects which will help in smooth transition to job market and research fields
- To keep with latest trends in industries

Semester – I						
Sl. no.	Course code	Course Title	L	T	P	C
1.	BS-5101	Optimization Theory and Applications	3	0	0	3
2.	BS-5102	Advanced Algebra	3	0	0	3
3.	BS-5103	Differential Equations	3	0	0	3
4.	BS-5104	Discrete Mathematics	3	0	0	3
5.	BS-5105	Probability and Statistics	3	0	0	3
6.	BS-5106	Scientific Computing	3	0	0	3
7.	BS-5107	Probability and Statistics Lab.	0	0	2	1
8.	BS-5108	Scientific Computing Lab.	0	0	2	1
Semester – II						20
9.	BS-5201	Introduction to Data Science	3	0	0	3
10.	BS-5202	Artificial Intelligence and Machine Learning	3	0	0	3
11.	BS-5203	Data Structures and Algorithms	3	0	0	3
12.	BS-5204	Quantum Computing	3	0	0	3
13.	BS-5205	Mathematical Modelling and Simulations	3	0	0	3
14.	BS-5206	Statistical Regression	3	0	0	3
15.	BS-5207	Artificial Intelligence and Machine Learning Lab.	0	0	2	1
16.	BS-5208	Data Structures and Algorithms Lab.	0	0	2	1
Semester – III						20
17.	BS-5301	Number Theory and Cryptography	3	0	0	3
18.	BS-5302	Business Analytics	3	0	0	3

19.	BS-5303	Industrial Electives-I	3	0	0	3
20.	BS-5304	Industrial Electives-II	3	0	0	3
21.	BS-5305	Quantitative Finance	3	0	0	3
22.	BS-5306	Generative AI	3	0	0	3
23.	BS-5307	Quantitative Finance Lab.	0	0	2	1
24.	BS-5308	Generative AI Lab.	0	0	2	1
Semester - IV						20
25.	BS-5401	Elective (Online or NPTEL or as faculty advisor)				4
26.	BS-5402	Internship/Project				10
						74

List of Electives

S. No.	Topics	Credits
1	Classical Fluid dynamics	3
2	Measure Theory (Real & Functional)	3
3	River modeling/Fluvial sedimentation modeling	3
4	Statistical mechanics	3
5	Climate change modeling	3
6	Portfolio Theory and Risk Management	3
7	Thin films	3
8	Plasma Physics	3
9	Particle Dynamics	3
10	Statics	3
11	Glaciers Modeling	3
12	Hypersonic fluid flow	3
13	Computational Chemistry	3
14	Advanced Data Science	3
15	Gaussian Process	3
16	Generative Models	3
17	Energy based methods	3
18	Diffusion models	3
19	Reinforcement learning	3

20	High Performance Computing	3
21	Deep Learning for the Life Science	3
22	Graph Theory	3
23	Complex Network Analysis	3
24	Functional Analysis & Topology	3
25	Probabilistic Machine Learning	3
26	Course suggested by Instructor with students consent from NPTEL or other institute recognized MOOC's portal or Physical mode course.	3

Eligibility:

B.Sc.(Physics/Mathematics/Computer Science/Data Science/IT) & B. Tech. or equivalent

M. Sc. DATA SCIENCE S SYLLABUS

		राष्ट्रीयप्रौद्योगिकीसंस्थानअरुणाचलप्रदेश NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH (शिक्षामंत्रालय, भारत सरकारकेतहतराष्ट्रीयमहत्वकासंस्थान) (Institute of National Importance under Ministry of Education, Govt. of India)												CURRICULUM				
Programme		M.Sc. Data Science										Academic Year of Regulation				2025-26		
Department		Basic and Applied Science										Semester				I		
Course Code		Course Name		Credit Structure						Marks Distribution						Bloom's taxonomy		
				L	T	P	C	INT	MID	END	Total							
BS-5101		Optimization Theory and Applications		3	0	0	3	20	30	50	100							
Course Objectives		To learn various optimization techniques involved in data science		Course Outcomes		CO1		(i) After going through this course the students will be able to formulate problems in optimization techniques						Understanding/ Comprehension				
						CO2		(ii) Solve using Optimization techniques						Identify/ Knowledge/ Remember				
						CO3		(iii) Implement and extend it to real world scenario						Understanding/ Analyzing				
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content												Hours		COs			
I	Mathematical foundations and concepts of linear optimization, simplex method, revised simplex method, duality, sensitivity analysis												10		CO1, CO2, CO3			
II	Basic descent methods: Line search methods, steepest descent, and Newton methods; Constrained optimization: first order necessary conditions, second order necessary conditions, Karush-Kuhn-Tucker (KKT) conditions, constraint qualification												10		CO1, CO2, CO3			

III	Convex programming problem; Dynamic programming; Quadratic programming: Active set methods, gradient projection methods and sequential quadratic programming	10	CO1, CO2, CO3
IV	Goal Programming: Concept of goal programming, model formulation, graphical solution method; multi-objective programming; Interior point methods; Karmarkar's algorithm	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. S. S. Rao, Optimization: Theory and Applications, Halsted Press, 1984.			
2. Rajesh Kumar Arora, Optimization: Algorithms and Applications, Chapman and Hall, 2015			
Reference Books			
1. Stephen P. BoydStephen P. Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University, 2016			
2. Hamdy H. Taha, Operations Research: A Introduction, Pearson Publications, 2007			



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CURRICULUM

Programme		M.Sc. Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					I		
Course Code		Course Name				Credit Structure					Marks Distribution						
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy			
BS-5102		Advanced Algebra				3	0	0	3	20	30	50	100				
Course Objectives		To learn the concepts in Advanced Algebra				Course Outcomes	CO1	i) To learn the concepts of Advanced Algebra						Understanding/ g/ Comprehension			
							CO2	ii) To understand to think in abstract way						Identify/ Knowledge/ Remember			
							CO3	iii) Advance the concept in Advanced Algebra						Understanding/ g/ Analyzing			
No.	COs	Mapping with Program Outcomes(POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content												Hours	COs			
I	Introduction to Modules, Sub modules quotient modules, Module Homomorphism, Isomorphism, Finitely generated modules, cyclic modules												10	CO1, CO2, CO3			
II	Simple modules, Semi simple modules, Free modules, Schur's lemma												10	CO1, CO2, CO3			
III	Noetherian & Artinian modules and rings, Hilbert basis theorem, Wedderburn-Artin theorem												10	CO1, CO2, CO3			

IV	Uniform modules, Primary modules, Noether-Laskar theorem, Fundamental structure theorem of modules over a principal ideal domain and its applications to finitely generated abelian groups	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. I.N. Herstein, Topics in Algebra, Wiley Eastern, New Delhi			
2. V. Sahai & V. Bisht, Algebra, Narosa Publishing House			
Reference Books			
1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University Press			
2. N. Jacobson, Basic Algebra, vol. II & VIII, Hindustan Publishing Company			
3. S. Lang, Algebra, Addison- Wesley			
4. I. S. Luther & I.B.S. Passi Algebra Vol-1,2,3, Narosa company			

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Programme		M.Sc. Data Science										Academic Year of Regulation				2025-26		
Department		Basic and Applied Science										Semester				I		
Course Code		Course Name		Credit Structure							Marks Distribution							
				L	T	P	C	INT	MID	END	Total	Bloom's taxonom y						
BS-5103		Differential Equations		3	0	0	3	20	30	50	100							
Course Objectives		The students will learn the governing mathematical formulations and their solutions of various physical problems.		Course Outcomes		CO1		After going through this course the students will be able to (i) Formulate the governing Mathematical equations of Physical Problems.							Understandi ng/ Comprehensi on			
						CO2		(ii) Solve Differential Equations using various Mathematical tools.							Identify/ Knowledge/ Remember			
						CO3		The subject Partial Differential equations have wide range of applications in engineering and technological sciences. Using Partial Differential equations, students can solve wave equations, heat equations, Laplace equations etc							Understandi ng/ Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content												Hours	COs				
I	Unit I: Ordinary Differential Equations Series solutions of second order linear differential equations, Legendre equation and Legendre polynomials, Bessel equation and Bessel functions, Systems of first-order linear differential equations												10	CO1, CO2, CO3				

II	Unit II: Partial Differential Equations of Second Order Liner partial differential equations of second order with constant co-efficient, Characteristic curves of second order equations, Reduction to canonical forms, Separation of variables	10	CO1, CO2, CO3
III	Unit III. Laplace's Equation, Wave Equation, Diffusion Equation The occurrence of Laplace's equation in Physics, Elementary solutions of Laplace's equation, Boundary value problem, Solution of Laplace's equation by separation of variables, The occurrence of the Wave equation in Physics, Elementary solutions of the one-dimensional Wave equation, Solution of the Wave equation by separation of variables The occurrence of the Diffusion equation in Physics, Elementary solutions of the Diffusion equation, Solution of the Diffusion equation by separation of variables	10	CO1, CO2, CO3
IV	Unit IV: Methods of Green's Function Green's Function, Green's Function for the Laplace's equation, Green's Function for the Wave equation, Green's Function for the Diffusion equation	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Ross, S. L. (1984), Differential Equations, Wiley India			
2. Coddington, E. A. (2001), An Introduction to Ordinary Differential Equations, PHI			
Reference Books			
1. Boyce, W. E., DiPrima, R. C. (2009), Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India			
2. Piaggio, E. T. H. (1985), Differential Equations, CBS Publishers and Distributors			
3. Bhamra, K. S. (2010), Partial Differential Equations, PHI Learning Pvt. Ltd			
4. Ayres, F (Jr.). (1972), Theory and Problems of Differential Equations, SI (Metric) Edition, Schaum Outline Series. McGraw Hill Book Co			
5. Website and E-learning Source: http://mathforum.org , http://ocw.mit.edu/ocwweb/Mathematics , http://www.opensource.org			
6. Sneddon, I. N. (2006), Elements of Partial Differential Equations, Dover Publications, Inc			
7. Rao, K. S. (2010), Introduction to Partial Differential Equations, PHI Learning Pvt. Ltd			
8. Przemyslaw Bogacki Maurice D. Weir, Joel Hass, Christopher Heil, Thomas' Calculus, Pearson, 2024			
9. Daniel K. Clegg, James Stewart, Saleem Watson, Calculus: Early Transcendentals, 2023			



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CURRICULUM

Programme		M.Sc., Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					I		
Course Code		Course Name				Credit Structure					Marks Distribution						
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy			
BS-5104		Discrete Mathematics				3	0	0	3	20	30	50	100				
Course Objectives		1. To extend student's Logical and Mathematical maturity and ability to deal with abstraction and to introduce most of the basic terminologies used in computer science courses and application of ideas to solve practical problems 2. Apply logical reasoning to solve a variety of problems.				Course Outcomes	CO1	Understand the basic concepts of set and counting, relation and function, group and ring, discrete numeric function and generating function, recurrence relation and recursive algorithm, boolean algebra and graph theory.						Understanding/Comprehension			
							CO2	Describe the properties of set and counting, relation and function, group and ring, discrete numeric function and generating function, recurrence relation and recursive algorithm, boolean algebra and graph theory.						Identify/Knowledge/Remember			
							CO3	Solve the fundamental problems related to discrete structure.						Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content												Hours	COs			
I	Sets and Properties: Finite and Infinite Sets, Combinations of Sets, Countable and uncountable Sets, Mathematical Induction, Principle of Inclusion and Exclusion, Pigeonhole Principles, Propositional logic. Relations and Functions: Properties of Binary Relations, Equivalence Relations and Partitions, Partial Ordering, Partial order relation, Relations and Lattices												10	CO1, CO2, CO3			
II	Group and Rings: Groups, Subgroups, Permutation Groups, Cyclic group, Cosets and Lagrange's Theorem, Rings, Integral Domains and Fields												10	CO1, CO2, CO3			

III	Discrete Numeric Functions and Generating Functions: Manipulation of Numeric Functions, Asymptotic Behavior of Numeric Functions, Generating Functions Recurrence Relations and Recursive Algorithms: Recurrence Relations, Linear Recurrence Relations with Constant Coefficients Boolean Algebra: Lattices and Algebraic Systems, Principle of Duality, Basic Properties of Algebraic System	10	CO1, CO2, CO3
IV	Graph Theory: Basic concepts, Graph isomorphism, Bipartite graph, Subgraph, Degree, Walk, Path, Cycle, Connectivity Cut vertices and cut edges, Trees, Binary tree, Spanning trees, Euler graph, Euler tours and Hamiltonian cycles	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1 C.L. Liu, Elements of Discrete Mathematics, McGraw Hill Education; 4th edition, 2017			
2. D.S. Malik and M. K. Sen, Discrete Mathematical Structures: Theory and Applications, Cengage; 1 st edition, 2012			
Reference Books			
1. K. H. Rosen, Discrete Mathematics and its Applications, McGraw Hill Education; 7th edition, 2017			
2. Kolman B, Busby R. C, Ross S.C, “Discrete Mathematical Structures”, PHI Learning, 2011			
3. S. Lipschutz, Marc L. Lipson, “Discrete Mathematics”, Schaum’s outlines, Print, 3th edition, 2013			
4. Norman L. Biggs, “Discrete Mathematics”, Oxford, 2nd Edition, 2009			
5. Rowan Garnier & John Taylor, “Discrete Mathematics”, Oxford, 2 nd Edition, 2009			
6. R. Johnsonbaugh, “Discrete Mathematics”, Pearson, 8 th Edition, 2017			
7. N. Deo, with Applications to Engineering and Computer Science, Prentice Hall India Learning Private Limited; 9 th edition, 1979			
8. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, McGraw Hill Education; 1 st edition, 2017			
9. T. Koshy, Discrete Mathematics with Applications, Academic Press Inc, 2014			
10. I. N. Herstein, Topics in Algebra, Wiley India Pvt. Ltd., 2006			

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Course Code		Course Name				Credit Structure							Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS -5105		Probability and Statistics				3	0	0	3	20	30	50	100					
Course Objectives		1. Students will be well versed in converting Mathematical and Physical concepts taught in the class into programming code. 2. Will know the details of computational coding.				Course Outcomes		CO1		Will learn Computer coding.					Understanding/Comprehension			
								CO2		Will learn to convert Mathematical and Physical concepts arising in classroom to programming					Identify/Knowledge/Remember			
								CO3		Will get know the details and finer parts of computational coding.					Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content												Hours	COs				
I	Programming for Probability and Data Analysis Domains and probabilities - Stochastic variables and the main concepts, the discrete case - Properties of PDFs - Expectation values - Probability Distribution Functions - Uniform distribution - The exponential distribution – covariance												6	CO1, CO2				
II	Sampling and Estimation Introduction to Sampling - Population Parameters and Sample Statistic - Sampling - Probabilistic Sampling - Non-Probability Sampling - Sampling Distribution - Central Limit Theorem (CLT) - Concepts and Applications												6	CO1, CO2, CO3				

III	Confidence Intervals Introduction to Confidence Interval - Confidence Interval for Population Mean - Confidence Interval for Population Proportion - Confidence Interval for Population Mean When Standard Deviation is Unknown - Confidence Interval for Population Variance	14	CO1, CO2, CO3
IV	Hypothesis Testing Introduction to Hypothesis Testing - Difference In Two Population - Means When Population Standard Deviations are Unknown and not Equal: Two-sample <i>t</i> -Test with Unequal Variance in Population Proportion under Large Samples: Two-Sample Z-Test for Proportions - Effect Size: Cohen's D - Hypothesis Test for Equality of Population Variances - Non-Parametric Tests: Chi-Square Tests - Chi-Square Goodness of Fit Tests - Choice of Number of Intervals in Chi-Square Goodness of Fit Test - Chi-Square Test of Independence	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, Ninth Edition, Prentice Hall, 2011			
2. U. Dinesh Kumar, Business Analytics, Wiley, 2017 & Series			
Reference Books			
1. Johannes Ledolter, Data mining and business analytics with R			
2. Galit Shmueli Galit Shmueli, Peter C. Bruce, Amit V. Deokar, Nitin R. Patel, Machine learning for Business Analytics with Python, Wiley, 2023			
3. Manoranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wiley, 2018			
4. Peyton Z. Peebles, Probability Random Variables, and Signal Principles, McGraw Hill Inc., 2001			
5. Jim Pitman, Probability, Springer, 1993			

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Programme		M.Sc. Data Science								Academic Year of Regulation				2025-26		
Department		Basic and Applied Science								Semester				I		
Course Code		Course Name		Credit Structure					Marks Distribution							
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS-5106	Scientific Computing	3	0	0	3	20	30	50	100							
Course Objectives		1. Students will be well versed in converting Mathematical and Physical concepts taught in the class into programming code. 2. Will know the details of computational coding.		Course Outcomes		CO1		Will learn Computer coding.						Understanding/ Comprehension		
						CO2		Will learn to convert Mathematical and Physical concepts arising in classroom to programming						Identify/ Knowledge/ Remember		
						CO3		Will get know the details and finer parts of computational coding.						Understanding/ Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		
I	Probability and Data Analysis Domains and probabilities - Stochastic variables and the main concepts, the discrete case - Properties of PDFs - Expectation values - Probability Distribution Functions - Uniform distribution - The exponential distribution - Covariance												6	CO1, CO2		

II	Linear Algebra, Handling of Arrays and Python Matrix and vector handling packages – Matrices - Numpy and arrays - Matrix and Vector Operations - Gaussian Elimination - LU Decomposition, the inverse of a matrix	6	CO1, CO2, CO3
III	Linear Regression – Ridge and Lasso Regression – Resampling Method – Logistic Regression – Optimization – Support Vector Machines – Decision Trees – Ensemble Methods - Basic ideas of the Principal component analysis (PCA) – Clustering and Unsupervised learning	14	CO1, CO2, CO3
IV	Neural Networks and Deep Learning - A Simple Neural Network - Activation Functions - Forward Propagation - Backpropagation - Calculating the Weight and Bias Derivatives - Stochastic Gradient Descent - Using scikit-learn - Limitations of Neural Networks and Deep Learning – Conclusion	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Manorajan Pradhan, U. Dinesh Kumar, Machine learning using Python, Wiley, 2019			
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022			
Reference Books			
1. Thomas Nield, Essential Math for Data Science, O'Reilly, 2022			
2. Pradeep Singh, Fundamentals and Methods of Machine and Deep Learning, Algorithms, Tools and Applications, Wiley 2022			
3. Tong Zhang, Mathematical Analysis of Machine Learning Algorithms, Cambridge University Press, 2023			
4. Yuxi (Hayden) Liu, Python Machine Learning By Example, Packt, 2020			
5. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning, Packt, 2017			

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Programme		M.Sc. Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					I		
Course Code		Course Name		Credit Structure					Marks Distribution						Bloom's taxonomy		
				L	T	P	C	INT	MID	END	Total						
BS-5107		Probability and Statistics Lab.		0	0	2	1	0	0	100	100						
Course Objectives		1. Students will be well versed in converting Mathematical and Physical concepts taught in the class into programming code. 2. Will know the details of computational coding.		Course Outcomes	CO1	Will learn Computer coding.						Understanding/Comprehension					
					CO2	Will learn to convert Mathematical and Physical concepts arising in classroom to programming						Identify/Knowledge/Remember					
					CO3	Will get know the details and finer parts of computational coding.						Understanding/Analyzing					
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content												Hours	COs			
I	Explanatory Data Analysis and Probability (Using R and Python) Concepts of R ; Elements of Structured Data; Estimates of Location; Estimates of Variability; Exploring the Data Distribution; Probabilities - Stochastic variables & discrete case – Plotting PDFs - Finding Expectation values – Plotting standard distributions - The exponential distribution												6	CO1, CO2			

II	Data and Sampling Distributions Random Sampling and Sample Bias; Sampling Distribution of a Statistic; BootStrap; Confidence Intervals; Normal Distirbutions; Student's t-Distribution; Chi-Square Distribution; Poisson Distributions	6	CO1, CO2, CO3
III	Statistical experiments and Significance testing Hypothesis Tests; Resampling; Statistical Significance and p-Values; Degree of Freedom; ANOVA ; Chi-Square Test Variance	9	CO1, CO2, CO3
IV	Statistical Machine Learning K-Nearest Neighbors; Tree Models; Bagging and the Random Forest ; Boosting	9	CO1, CO2, CO3
Total Hours		30	
Text Books			
1. An Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hate, and Robert Tibshirani, Springer, 2015			
2. Practical Statistics for Data Scientists, Peter Bruce, Andrew Bruce, and Peter Gruce, O'Reilly, 2020			
Reference Books			
1. Johannes Ledolter, Data mining and business analytics with R			
2. Galit Shmueli Galit Shmueli, Peter C. Bruce, Amit V. Deokar, Nitin R. Patel, Machine learning for Business Analytics with Python, Wiley, 2023			
3. Manoranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wiley, 2018			
4. Peyton Z. Peebles, Probability Random Variables, and Signal Principles, McGraw Hill Inc., 2001			
5. Jim Pitman, Probability, Springer, 1993			

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Programme		M.Sc. Data Science										Academic Year of Regulation			2025-26		
Department		Basic and Applied Science										Semester			I		
Course Code		Course Name				Credit Structure					Marks Distribution						
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy			
BS-5108		Scientific Computing Lab.				3	0	2	1	0	0	100	100				
Course Objectives		1. Students will be well versed in converting Mathematical and Physical concepts taught in the class into programming code. 2. Will know the details of computational coding.				Course Outcomes		CO1		Will learn Computer coding.						Understanding/Comprehension	
								CO2		Will learn to convert Mathematical and Physical concepts arising in classroom to programming						Identify/Knowledge/Remember	
								CO3		Will get know the details and finer parts of computational coding.						Understanding/Analyzing	
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content												Hours	COs			
I	Introduction to Python and Numerical methods (Python) Concepts of Python; Programs to finding roots of algebraic equations; Programs to solving linear equations;												6	CO1, CO2			
II	Programs to simulate Regression Linear Regression: The Regression equation-Fitted Values and Residuals-Least squares-Prediction versus Explanation; Multiple Linear Regression: Example-Assessing the model-Cross Validation-Model Selection and Stepwise Regression												8	CO1, CO2, CO3			

III	Classification Simulation Naïve Bayes-Naïve Solution-Numeric Predictor Variables; Discriminant Analysis:Covariance Matrix; Logistic Regression- Logistic Response Function-Logistic Regression	14	CO1, CO2, CO3
IV	Programs in Text Processing, Natural Language Processing and Time Series analysis. Additional programming in latest topics (Optional)	12	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022			
2. Thomas Nield, Essential Math for Data Science, Take Control of Your Data with Fundamental Linear Algebra, Probability, and Statistics, O'Reilly, 2022			
Reference Books			
1. Manoranjan Pradhan, U Dinesh Kumar, Machine Learning using Python, Wiley, 2019			
2. Pradeep Singh, Fundamentals and Methods of Machine and Deep Learning, Algorithms, Tools and Applications, Wiley 2022			
3. Tong Zhang, Mathematical Analysis of Machine Learning Algorithms, Cambridge University Press, 2023			
4. Yuxi (Hayden) Liu, Python Machine Learning By Example, Packt, 2020			
5. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning, Packt, 2017			
6. William Miles, Numerical methods with Python for the Sciences, De Gruyter, 2023			
7. Raymond Canale, Steven C. Chapra, Numerical. Methods for Engineers, McGraw Hill, 2012			

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Programme		M.Sc. Data Science								Academic Year of Regulation				2025-26		
Department		Basic and Applied Science								Semester				II		
Course Code		Course Name		Credit Structure					Marks Distribution							
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS-5201		Introduction to Data Science		3	0	0	3	0	0	0	100	100				
Course Objectives		1. Students will be well versed in concepts of Data Science 2. Students will be know the directions to the solutions of the problems.		Course Outcomes		CO1		Will learn concepts of Data Science						Understanding/ Comprehension		
						CO2		Will learn the connection between Mathematics and Data						Identify/ Knowledge/ Remember		
						CO3		Will get know how to apply the learnt concepts to data and make useful conclusions from data.						Understanding/ Analyzing		
No. COs		Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1 CO1		3	2	1												
2 CO2		3	2	1												
3 CO3		3	3	3	3	1										
SYLLABUS																
No.		Content												Hours	COs	
I		Neural Networks-Structure-Objectives-Artificial neuron: An adaptive basis function Feed Forward neural network Training neural network-Stochastic Gradient Descent Computing- Error derivatives-Backpropagation algorithm-Challenges of training neural networks-Modifications of SGD-Momentum methods-Adaptive learning rate-Bias-variance trade-off in neural networks-Regularization of neural nets												6	CO1, CO2	
II		Clustering-Structure Objectives-Forming clusters-Distance and similarity-Cluster quality-Internal evaluation- Clustering algorithms-Partition-based clustering-K-means-Density-based clustering-DBSCAN-Distribution-based clustering												10	CO1, CO2, CO3	
III		Dimensionality Reduction-Structure-Objectives- Reducing dimensionality - Principal Component Analysis - Loading Iris												10		

	dataset - Calculating covariance matrix - Decomposition of covariance matrix - Reducing with principal components - Variance retention - When to use PCA		
IV	Data Science - A Brief History of Data Science - Finding Your Edge - SQL Proficiency - Programming Proficiency - Data Visualization - Industry Practices – Applications of Convolutional Neural Network & Recurrent Neural Network – Advanced topics in all the units (Optional)	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Tamoghna Ghosh, Shravan Kumar Belagal Math, Practical Mathematics for AI and Deep Learning, BPB Publications, 2023			
2. François Chollet & Mathew Watson, Deep learning using Python, Manning, 2025			
Reference Books			
1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022			
2. Ian GoodFellow and Yoshua Bengio & Aaron Courville, Deep learning, MIT Press, 2016			
3. Ivan Vasilev, Advanced Deep Learning with Python, Packt Publications, Birmingham – Mumbai, 2019			
4. Rowel Atienza, Advanced Deep Learning with TensorFlow 2 and Keras, Packt Publications, Birmingham – Mumbai, 2020			
5. Otmar Scherzer, Bernd Hofmann, Zuhair Nashed, Gauss Newton method for solving linear inverse problems with neural network coders, Sampling theory, Signal Processing, and Data Analysis, 2023, 21:25, Birkhäuser. https://doi.org/10.1007/s43670-023-00066-6			
6. https://en.wikipedia.org/wiki/Universal_approximation_theorem			
7. https://www.geeksforgeeks.org/universal-approximation-theorem-for-neural-networks/			
8. https://mitliagkas.github.io/			
9. Charu C. Aggrawal, Neural Networks and Deep Learning: A Textbook, Springer, 2018			

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Programme		M.Sc. Data Science										Academic Year of Regulation				2025-26		
Department		Basic and Applied Science										Semester				II		
Course Code		Course Name		Credit Structure						Marks Distribution								
				L	T	P	C	INT	MID	EN D	Tot al	Bloom's taxonomy						
BS-5102		Artificial Intelligence and Machine Learning		3	0	0	3	20	30	50	100							
Course Objectives		1. To know the concepts of Mathematics in Deep learning 2. To make decisions using concepts of Deep learning and use it in applications		Course Outcomes		CO1		Will learn concepts of Deep learning						Understanding / Comprehension				
						CO2		Will learn concepts of Mathematics applied in Deep learning						Identify/ Knowledge/ Remember				
						CO3		Will get know various techniques to use in different real time cases using Deep learning						Understanding/ Analyzing				
No.	COs	Mapping with Program Outcomes(POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content													Hours		COs		
I	Vector Calculus –Single variable calculus–Derivatives –Sum rule-Power rule-Trigonometric functions –First and Second derivatives-Product rule-Quotient rule-Chain rule-Anti derivative–Integrals –The fundamental theorem of calculus Substitution rule-Areas between curves –Integration by parts –Multivariable calculus –Partial derivatives – Chain rule- Integrals - Derivatives- Vector fields - Inverse functions													6		CO1,CO2		

II	Optimization-Understanding optimization and it's different types -Constrained optimization-Unconstrained optimization- Convex optimization - Convex sets - Affine sets- Convex functions - Optimization problems - Non-convex optimization Feed forward Neural Networks –Understanding biological neural networks -The MP neuron-Perceptron-Pros and cons of the MP neuron and perceptron	10	CO1,CO2,CO3
III	MLPs -Layers –Activation functions-Sigmoid-Hyperbolic tangent-Softmax-Rectified linear unit-LeakyReLU-Parametric ReLU-Exponential linear unit –The loss function-Mean absolute error –Mean squared error –Root mean squared error –Backpropagation	10	CO1,CO2,CO3
IV	Regularization -The need for regularization-Norm penalties-L2 regularization-L1 regularization-Early stopping-Parameter tying and sharing Dataset augmentation-Dropout-Adversarial training-Advanced topics (Optional)	14	CO1,CO2,CO3
Total Hours		40	
Text Books			
1. Mark E. Fenner, Machine learning using Python for everyone, Pearson, 2019			
2. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020			
Reference Books/Links			
1. Manoranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wiley, 2019			
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, 2020			
3. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly Media, 2022			
4. S. S. Vinod Chandra, S. Anand Hareedran, Machine Learning: A Practitioner's Approach, 2021, PHI Learning Private Limited			
5. Francis X. Govers, Artificial Intelligence for Robotics, Packt, 2018			
6. Logashanmugam E., Martin Margala, Minu R.I., Nagarajan G., Siva Shankar S, Exploring the fusion of Quantum computing and Machine learning, IGI Global Scientific Publishing, 2025			
7. https://www.geeksforgeeks.org/machine-learning/machine-learning/			
8. https://nptel.ac.in/courses/106106139			

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Programme		M.Sc. Data Science										Academic Year of Regulation				2025-26		
Department		Basic and Applied Science										Semester				II		
Course Code		Course Name		Credit Structure					Marks Distribution									
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy						
BS-5203		Data Structures and Algorithms		3	0	0	3	20	30	50	100							
Course Objectives		1. Students will understand the basics of Advanced concepts of Probability and Statistics. 2. Apply the above knowledge to understand problems in real world with programming knowledge.		Course Outcomes		CO1		Understand the advanced concepts of Probability and Statistics.							Understanding/ Comprehension			
						CO2		Describe the links between the concepts learnt and real time data							Identify/ Knowledge/ Remember			
						CO3		To write programming code for the learnt Probability and Statistics concepts							Understanding/ Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content												Hours	COs				
I	Introduction to Data Structures and Algorithms Data Structures – Elementary Data Organization, Classification of Data Structures, Operations on Data Structures, Abstract Data Types Analysis of Algorithm – The Big-Oh, Big-Omega, Big-Theta, Small-Oh, Small-Omega Recursion Analyzing Recursive Algorithms – Designing Recursive Algorithms												6	CO1, CO2, CO3				

II	Array-Based Sequences Low level Arrays – Dynamic Arrays – Array Based Sequences Stacks Stack Abstract Data Type – Simple Array Based Stack Implementation	6	CO1, CO2, CO3
III	Queues & Linked Lists Queue Abstract Data Type – Array Based Queue – Double Ended Queue – Circular Queue - Singly Linked Lists – Circularly Linked Lists – Doubly Linked Lists	14	CO1, CO2, CO3
IV	Trees, Maps, Hash Tables, Sets & Sorting and Graph Algorithms Binary trees – Tree Traversal Algorithms – Maps & Dictionaries – Hash Tables – Sorted Maps – Sets – Sorting and Graph Algorithms	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Subhrakanta Panda, Data Structures and Algorithms in Python, Wiley, 2024			
2. Clifford A. Shaffer, Data Structures and Algorithm Analysis in Java, Dover Publications, 2017			
Reference Books/Links			
1. Mark Allen Weiss, Data Structures and Algorithm Analysis in Java, Pearson, 2012			
2. Jay Wengrow, A Common-Sense Guide to Data Structures and Algorithms, The Pragmatic Self, 2017			
3. https://www.geeksforgeeks.org/dsa-tutorial-learn-data-structures-and-algorithms/			
4. https://www.tutorialspoint.com/data_structures_algorithms/index.htm			
5. https://onlinecourses.nptel.ac.in/noc25_cs148/preview			
6. Mingyuan Li, Duan Wang, Erick Purwanto, Thomas Selig, Qing Zhang, Hai-Ning Liang, VisualCodeMOOC: A course platform for algorithms and data structures integrating a conversational agent for enhanced learning through dynamic visualizations, SoftwareX, Vol. 30, May 2025, 102072			
7. Maodong Pan, Ruijie Zou, Bert Jüttler, Algorithms and data structures for C^s -smooth RMB-splines of degree $2s + 1$, Volume 114, November 2024, 102389			

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Programme		M.Sc. Data Science								Academic Year of Regulation				2025-26		
Department		Basic and Applied Science								Semester				II		
Course Code		Course Name		Credit Structure					Marks Distribution							
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS-5204	Quantum Computing	3	0	0	3	20	30	50	100							
Course Objectives		1. To know the concepts of linking Quantum Mechanics and Quantum Computing 2. To know the concepts of Quantum Computing		Course Outcomes	CO1	Will learn concepts of Quantum Mechanics							Understanding/Comprehension			
					CO2	Will learn how the concepts in Quantum Computing							Identify/Knowledge/Remember			
					CO3	Will get to know the connection between Physics and Computing						Understanding/Analyzing				
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		
I	Quantum Mechanics Physical Background - The Double-Slit Experiment - Wave Functions - State Space - The Schrödinger Equation												6	CO1, CO2		

II	One Qubit Introducing quantum bits - Bras and kets- The complex math and physics of a single qubit - Quantum state representation - Unitary matrices mapping to standard form - The density matrix - Observables and expectation - A non-linear projection - The Bloch sphere – Pauli Gate - The quantum X gate - The quantum Z gate - The quantum Y gate - The quantum ID gate - The quantum H gate - The quantum Rz gates - The quantum S gate - The quantum Sy gate - The quantum T gate - The quantum Ty gate - The quantum Rx and Ry gates - The quantum under root NOT gate	12	CO1, CO2, CO3
III	Two and Three Qubits Tensor products - Entanglement - Multi-qubit --Constructing a circuit-Amplitude amplification – Searching -The Deutsch-Jozsa algorithm - Simon’s algorithm	12	CO1, CO2, CO3
IV	Quantum Fourier Transform Factoring - Phase estimation - Order and period finding - Shor’s algorithm - Light and photons – Decoherence - Error correction - Quantum Volume - The software stack and access – Simulation – Future prospects of Quantum computing	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Ajit Kumar, Fundamentals of Quantum Mechanics, Cambridge Press University, 2018			
2. Robert S. Sutor, Dancing with Qubits, Packt, 2019			
Reference Books/Link			
1. Anshul Saxena, Javier Mancilla, Iraitz Montalban, Christophe Pere, Financial Modeling Using Quantum Computing, Packt, 2023			
2 . Venkateswaran Kasirajan, Fundamentals of Quantum Computing, Theory and Practice, Springer, 2021			
3. Leonard S. Woody III, Mathematics for Quantum Computing, Packt, 2022			
4. Wolfgang Scherer, Mathematics of Quantum Computing, An Introduction, Springer, 2019			
5. Sarah Kaiser, Chris Granade, Learn Quantum Computing with Python and Q#, Manning, 2022			
6. Maria Schuld, & Francesco Petruccione, Machine learning with Quantum Computers, Springer, 2021			
7. Michael A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information, CUP, 2010			
8. Maria Schuld, Francesco Petruccione , Supervised Learning with Quantum Computers, Springer, 2018			
9. Elias F. Combarro, Samuel Gonzalez-Castillo, Alberto Di Meglio, A Practical Guide to Quantum Machine Learning and Quantum Optimization, Packt, 2023.			

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Programme		M.Sc. Data Science										Academic Year of Regulation			2025-26				
Department		Basic and Applied Science										Semester			II				
Course Code		Course Name		Credit Structure										Marks Distribution					
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy							
BS-5205		Mathematical Modelling and Simulation		3	0	0	3	20	30	50	100								
Course Objectives		To learn how model physical problems and use techniques to solve them		Course Outcomes		CO1		i) To learn about the different physical problems								Understanding/Comprehension			
						CO2		ii) To learn advanced numerical techniques								Identify/Knowledge/Remember			
						CO3		iii) To learn to solve physical problems using advanced numerical techiques								Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs					
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3			
1	CO1	3	2	1															
2	CO2	3	2	1															
3	CO3	3	3	3	3	1													
SYLLABUS																			
No.	Content												Hours	COs					
I	Introduction to Mathematical Modelling - Applications - Simulation of Semiconductor Electronics												10	CO1, CO2					

II	Simulation Techniques, Condensed Matter Physics Simulation and modeling – Material Science	12	CO1, CO2, CO3
III	Applications in Data Science: Modelling for predictive analytics, Optimization and decision-making models, Case studies in engineering, healthcare, and business analytics	12	CO1, CO2, CO3
IV	Advanced Numerical techniques and Visualization	6	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Donald A. Neamen, Semiconductor Physics and Devices- Basic Principles, McGraw Hill Education (India) Private Limited			
2. William F. Smith, Javad Hashemi, Francisco Presuel-Moreno, Foundations of Materials Science and Engineering, McGraw Hill Education (India) Private Limited, 2022			
Reference Books			
1. Keith B. Oldham, Jerome Spanier, The Fractional Calculus: Theory and Applications of Differentiation and Integration to Arbitrary Order, Dover Books on Mathematics, 2006			
2. Dale Anderson, John C. Tannehill, Richard H. Pletcher, Ramakanth Munipalli, Vijaya Shankar, Computational fluid mechanics and heat transfer, CRC Press, 2020			

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Programme		M.Sc. Data Science								Academic Year of Regulation				2025-26		
Department		Basic and Applied Science								Semester				II		
Course Code		Course Name				Credit Structure					Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy		
BS-5206		Statistical Regression				3	0	0	3	20	30	50	100			
Course Objectives		To learn concepts of Statistical Regression				Course Outcomes	CO1	i) To learn about the different concepts of Statistical Regression							Understanding/Comprehension	
							CO2	ii) To apply the Statiscal Regression to examples							Identify/Knowledge/Remember	
							CO3	iii) To apply the Statistical Regression using programming language							Understanding/Analyzing	
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		
I	Linear Regression - Descriptive Data Analysis - Multiple Linear Regression Models - Simple Linear Regression: One Independent Variable - Multiple Linear Regression: Moderation Analysis												10	CO1, CO2		
II	Introduction to Multi-Level Modeling - Multi-Level Data Structure - Intra-Class Correlation - Two-Level MLM - Longitudinal Data and Their Relationship to MLMs												12	CO1, CO2, CO3		
III	Two-Level Multi-Level Modeling - The Two-Level MLM - MLM Using R Package nlme - Model Selection with Likelihood Ratio												12	CO1, CO2, CO3		

	Chi-Square Test		
IV	Longitudinal Data Analysis - Data on Breast Cancer Post-surgery Assessment - Graphic Analysis - Longitudinal Models Using Function <i>lme</i> from <i>nlme</i> Package	6	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Ding-Geng (Din) Chen, Jenny K. Chen, Statistical Regression Modeling with <i>R</i> , Longitudinal and Multi-level Modeling, Springer, 2021			
2. Manoranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Springer, Wiley, 2019			
Reference Books			
1. U. Dinesh Kumar, Business Analytics, Wiley, 2017			
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning: Data Mining, Inference, And Prediction, Second Edition (springer Series In Statistics), Springer, 2019			
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, An Introduction to Statistical Learning: with Applications in R (Springer Texts in Statistics), Springer, 2017			
4. Kevin P. Murphy , Probabilistic Machine Learning: An Introduction, MIT, Press, 2022			
5. Aurélien Géron (Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, O' Rielly, Series, 2022			

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Programme		M.Sc. Data Science								Academic Year of Regulation				2025-26		
Department		Basic and Applied Science								Semester				II		
Course Code		Course Name				Credit Structure					Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy		
BS-5207		Artificial Intelligence and Machine Learning Lab.				0	0	2	1	0	0	100	100			
Course Objectives		1. To know the concepts of Mathematics in Deep learning 2. To make decisions using concepts of Deep learning and use it in applications				Course Outcomes	CO1	Will learn concepts of Deep learning						Understand- ing/ Comprehe- nsion		
							CO2	Will learn concepts of Mathematics applied in Deep learning						Identify/ Knowledg- e/ Remembe- r		
							CO3	Will get know various techniques to use in different real time cases using Deep learning						nderstand- g/ Analyzing		
No.	COs	Mapping with Program Outcomes(POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours		COs	
I	Introduction to Machine Learning : Types of Machine Learning- Applications of Machine Learning												2		CO1, CO2	

II	Machine Learning with Python Programs - NumPy Tutorial - Python Library - Pandas Tutorial - Data Preprocessing in Python - EDA - Exploratory Data Analysis in Python	4	CO1,CO2,CO3
III	Supervised learning & Feature Engineering - Dimensionality Reduction-Feature Selection Techniques in Machine Learning- Supervised Machine Learning - Linear Regression in Machine learning - Logistic Regression in Machine Learning - Decision Tree in Machine Learning - Random Forest Algorithm in Machine Learning - K-Nearest Neighbor(KNN) Algorithm - Support Vector Machine (SVM) Algorithm - Naive Bayes Classifiers	12	CO1,CO2,CO3
IV	Unsupervised Learning - K means Clustering – Hierarchical Clustering in Machine Learning-DBSCAN Clustering in ML - Principal Component Analysis (PCA)	12	CO1,CO2,CO3
Total Hours		30	
Text Books			
1. Manoranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wiley, 2019			
2. Tamoghna Ghosh, Shravan Kumar Belagal Math, Practical Mathematics for AI and Deep Learning, BPB Publications, 2023			
Reference Books			
1. Sebastian Raschka, Yuxi (Hayden) Liu, Vahid Mirjalili, Machine learning with PyTorch and Scikit-Learn, Packt, 2022			
2. https://deepakdvallur.weebly.com/machine-learning-laboratory.html			
3. https://github.com/livinNector/machine-learning-lab-exercises			
4. https://nptel.ac.in/courses/106106198			
5. https://nptel.ac.in/courses/106105152			
6. https://www.geeksforgeeks.org/machine-learning/machine-learning-with-python/			

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Programme		M.Sc. Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					II		
Course Code		Course Name		Credit Structure					Marks Distribution					Bloom's taxonomy			
				L	T	P	C	INT	MID	END	Total						
BS-5208		Data Structures and Algorithms Lab.		3	0	2	1	0	0	100	100						
Course Objectives		1. Students will understand the basics of Advanced concepts of Probability and Statistics. 2. Apply the above knowledge to understand problems in real world with programming knowledge.		Course Outcomes		CO1		Understand the advanced concepts of Probability and Statistics.					Understanding/Comprehension				
						CO2		Describe the links between the concepts learnt and real time data					Identify/Knowledge/Remember				
						CO3		To write programming code for the learnt Probability and Statistics concepts					Understanding/Analyzing				
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content												Hours	COs			
I	Introduction to C++ Input-Output-Example:Hello World-Variable and types-Strings-C++ Operator-C++ Math-C++ Boolean-If statement-else statement-else if statement-Switch Statements-Loop-Do/While-Break-Continue-Arrays- Functions												6	CO1, CO2, CO3			

II	Data Structures & Algorithms programming to understand Array-Vectors – Search Algorithms – Sorting Algorithms – Strings – Set	6	CO1, CO2, CO3
III	Data Structures and Algorithms programming to understand Map – Recursion – Queue – Stack – Linked List	14	CO1, CO2, CO3
IV	Data Structures and Algorithms programming to understand Tree – Heap – Graphs – Dynamic Programming	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Michael T. Goodrich, Roberto Tamassia, David Mount, Data Structures and Algorithms in C++ Second Edition, Wiley, 2011			
2. Clifford A. Shaffer, Data Structures and Algorithm Analysis in Java, Dover Publications, 2017			
Reference Books/Links			
1. Mark Allen Weiss, Data Structures and Algorithm Analysis in Java, Pearson, 2012			
2. Jay Wengrow, A Common-Sense Guide to Data Structures and Algorithms, The Pragmatic Self, 2017			
3. https://www.geeksforgeeks.org/dsa-tutorial-learn-data-structures-and-algorithms/			
4. https://www.tutorialspoint.com/data_structures_algorithms/index.htm			
5. https://onlinecourses.nptel.ac.in/noc25_cs148/preview			
6. Mingyuan Li, Duan Wang, Erick Purwanto, Thomas Selig, Qing Zhang, Hai-Ning Liang, VisualCodeMOOC: A course platform for algorithms and data structures integrating a conversational agent for enhanced learning through dynamic visualizations, SoftwareX, Vol. 30, May 2025, 102072			
7. Maodong Pan, Ruijie Zou, Bert Jüttler, Algorithms and data structures for C^s -smooth RMB-splines of degree $2s + 1$, Volume 114, November 2024, 102389			
8. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Subhrakanta Panda, Data Structures and Algorithms in Python, Wiley, 2024			



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 (Institute of National Importance under Ministry of Education, Govt. of India)

CURRICULUM

Programme		M.Sc., Data Science								Academic Year of Regulation				2026 - 27		
Department		Basic and Applied Science								Semester				III		
Course Code		Course Name				Credit Structure					Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy		
BS-5301		Number Theory and Cryptography				3	0	0	3	20	30	50	100			
Course Objectives		1 Students will understand the basics of Number Theory. 2 Apply the above knowledge to understand Cryptography.				Course Outcomes	CO1	Understand the basic concepts of number theory and cryptography.						Understanding/Comprehension		
							CO2	Describe the properties of number theory and cryptography.						Identify/Knowledge/Remember		
							CO3	Solve the fundamental problems related to number theory and cryptography.						Understanding/Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		

I	Preliminaries: The number system and the Well-Ordering Principle and Mathematical Induction. Divisibility and Factorization: Divisibility, Greatest Common Divisors, Euclidean Algorithm, Least Common Multiple. Solving Linear Diophantine Equations.	10	CO1, CO2, CO3
II	Primes: Prime Numbers, Unique Prime Factorization, test of Primality by Trial Division. Theory of Congruences : The concept of congruences, Congruence Classes, Applications of Congruences. Solving Linear Congruences : Solving (single) linear congruence, Solving system of linear congruences, the Chinese Remainder Theorem .	10	CO1, CO2, CO3
III	Fermat's Theorem and Euler's Generalization: Fermat's Little Theorem, the general case: Euler's theorem. Primitive Roots : The multiplicative order, Primitive Roots (mod n), the modulus n which does not have primitive roots , the Existence Theorems and Applications: The use of primitive roots. Quadratic Congruences : Euler's Criterion, the Legendre Symbol and its properties and examples of computing the Legendre symbol, Jacobi Symbol and Quadratic Residues and Primitive Roots.	10	CO1, CO2, CO3
IV	Cryptography : Introduction, Symmetric-key cryptography and Assymmetric Key or public key cryptography	10	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. Harold M. Stark. An Introduction to Number Theory Markham Publishing Company, 1970			
2. N. Koblitz. A course in number theory and cryptography. London: Springer Verlag, 1994			
Reference Books			
1. Joseph A. Gallian. Contemporary Abstract Algebra 4th Edition Houghton Mifflin Company, 1998			
2. M. Baldoni, C. Ciliberto, G. Cattaneo, & D. Gewurz. Elementary number theory, cryptography and codes. London: Springer, 2009			
3. A. Bruen Cryptography, information theory and error correction: A handbook for the 21st century. Hoboken, NJ: Wiley-Blackwell, 2011			
4. M. Herkommer Number theory: A programmer's guide. New York: Osborne/McGraw-Hill, 1998			
5. J. Hoffstein, J. Pipher, & J. Silverman. An introduction to mathematical cryptography (2nd ed.). London: Springer Verlag, 2014			
6. G. Jones Elementary number theory. London: Springer Verlag, 1998			
7. D. Kahn, The codebreakers: The comprehensive history of secret communication from ancient times to the internet. New York: Simon & Schuster, 1997			
8. K. H. Rosen. Elementary number theory and its applications. New York: Pearson/Addison Wesley, 2010			
9. Swenson, C. Modern cryptanalysis: Techniques for advanced code breaking. New York: John Wiley & Sons, 2008			
10. S. Wagstaff, Cryptanalysis of Number Theoretic Ciphers. Chapman and Hall/CRC, 2019			

		राष्ट्रीय प्रौद्योगिकी संस्थान अरुणाचल प्रदेश NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH (शिक्षा मंत्रालय, भारत सरकार के तहत राष्ट्रीय महत्व का संस्थान) (Institute of National Importance under Ministry of Education, Govt. of India)												CURRICULUM		
Programme		M.Sc. Data Science								Academic Year of Regulation				2026-27		
Department		Basic and Applied Science								Semester				III		
Course Code		Course Name				Credit Structure					Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy		
BS 5302		Business Analytics				3	0	0	3	20	30	50	100			
Course Objectives		1. To know the concepts of Statistics applied in business environment 2. To make decisions using concepts of Statistics and apply in Industrial scenario				Course Outcomes		CO1	Will learn concepts of Statistics used in Business world					Understanding/Comprehension		
								CO2	Will learn to forecast the future scenario					Identify/Knowledge/Remember		
								CO3	Will get know various techniques to use in different real time cases					Understanding/Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		

I	Analysis of Variance Variance (ANOVA)- Multiple <i>t</i> -Tests for Comparing Several Means - One-way Analysis of Variance (ANOVA) - Setting Up an Analysis of Variance - Cochran's Theorem - The <i>F</i> -Test - Two-Way Analysis of Variance (ANOVA)	6	CO1, CO2
II	Decision Trees Decision Trees: Introduction - Chi-Square Automatic Interaction Detection (CHAID) - CHAID Tree Development - Bonferroni Correction - Generating Business Rules using CHAID Tree - Classification and Regression Tree - Gini Impurity Index -	8	CO1, CO2, CO3
III	Forecasting Techniques Introduction to Forecasting - Time-Series Data and Components of Time-Series Data - Forecasting Techniques and Forecasting Accuracy - Mean Absolute Error (MAE) - Mean Absolute Percentage - Error (MAPE) - Mean Square Error (MSE) -Root Mean Square Error (RMSE) - Moving Average	12	CO1, CO2, CO3
IV	Stochastic Models Introduction Stochastic Process - Poisson Process - Compound Poisson Process - Markov Chains - Classification of States in a Markov Chain - Markov Chains with Absorbing States – Advanced topics (Optional)	14	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. U. Dinesh Kumar, Business Analytics, The Science of Data-Driven Decision Making, Wiley, 2017			
2. Manaranjan Pradhan, U Dinesh Kumar, Machine learning using Python, Wiley, 2019			
Reference Books			
1. François Chollet & Matthew Watson, Deep learning using Python, Manning, 2025			
2. Rowel Atienza, Advanced Deep Learning with TensorFlow 2 and Keras, Packt Publications, Birmingham – Mumbai, 2020			
3. Otmar Scherzer, Bernd Hofmann, Zuhair Nashed, Gauss Newton method for solving linear inverse problems with neural network coders, Sampling Theory, Signal Processing, and Data Analysis, 2023, 21:25, Birkhäuser. https://doi.org/10.1007/s43670-023-00066-6			
4. https://en.wikipedia.org/wiki/Universal_approximation_theorem			
5. https://www.geeksforgeeks.org/universal-approximation-theorem-for-neural-networks/			
6. https://mitliagkas.github.io/			

S. No.	Course Code	Subject name	Remarks
1	BS-5303	Industrial Elective-I	Will be assigned by Industrial Expert/Academic

			Expert in consultation with Department/students
2	BS-5304	Industrial Elective-II	Will be assigned by Industrial Expert/Academic Expert in consultation with Department/students

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Programme		M.Sc. Data Science										Academic Year of Regulation				2026-27		
Department		Basic and Applied Science										Semester				III		
Course Code		Course Name				Credit Structure							Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS-5105		Quantitative Finance				3	0	0	3	20	30	50	100					
Course Objectives		1. To know the concepts of Mathematical Finance 2. To implement the concepts of Mathematical Finance using computer.				Course Outcomes		CO1	Will learn concepts of Mathematical finance						Understanding/ Comprehension			
								CO2	Will learn how the concepts in Mathematical finance work in real time scenario						Identify/ Knowledge/ Remember			
								CO3	Will get know how to convert the Mathematical framework to computational framework						Understanding/ Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content												Hours	COs				
I	Basics Financial markets and instruments, risk-free and risky assets; Interest rates, present and future values of cash flows, term structure of interest rates, spot rate, forward rate; Bonds, bond pricing, yields, duration, term structure of interest rates;												10	CO1, CO2				

II	Financial Asset Dynamics Asset pricing models, Cox-Ross-Rubinstein binomial model, geometric Brownian motion model; Financial derivatives, no-arbitrage principle; Forward and futures contracts and their pricing, hedging strategies using futures, interest rate and index futures; Swaps and its valuation, interest rate swaps, currency swaps;	12	CO1, CO2, CO3
III	Option Pricing Equation Options, general properties of options, trading strategies involving options; Discrete time pricing of European and American derivative securities by replication; Continuous time pricing of European and American derivative securities by risk-neutral valuation;	10	CO1, CO2, CO3
IV	Numerical approach Finite difference approach to pricing European options and American options, free-boundary problem; Monte-Carlo approach to pricing financial derivatives.	8	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, 2 nd Edition, Springer, 2010			
2. D. Higham, Introduction to Financial Option Valuation: Mathematics, Stochastics and Computation, Cambridge University Press, 2004			
Reference Books			
1. Steven Shreve: Stochastic Calculus and Finance, Springer, 1997			
2. Steven Shreve, Stochastic calculus for Finance, Part I & II, Springer			
3. Sankarshan Basu, John C. Hull, Options, futures and other derivatives, Pearson Education; 2022 & Series, Pearson Education			
4. Paul Wilmott, Introduces Quantitative Finance, Second Edition, Wiley; 2nd edition (29 June 2007)			
5. Siddhartha Pratim Chakrabarthy, Mathematical Finance: https://youtu.be/IrWeySxY9OA?list=PLwdnzlV3ogoV-4hbV6DP3BjdmjuaQPjcr			
6. Siddhartha Pratim Chakrabarthy, Mathematical Portfolio Theory: https://youtu.be/EU1atD847oQ?list=PLwdnzlV3ogoVZdKHNNaoVbcFDVo0Wb0am			
7. Anindya Goswami, https://www.youtube.com/playlist?list=PLEAYkSg4uSQ0Gmh0ozZ1nugWbuzSuuhqa			
8. Brent Oksendal, Stochastic Differential Equations: An Introduction with Applications, Springer, 6 th edition, 2004 & Series			
9. Eric Chin, Sverrir Álafsson, Dian Nel, Problems and Solutions in Mathematical Finance, Volume 1: Stochastic Calculus (The Wiley Finance Series), Wiley; 1st edition, 10 October 2014			
10. Eric Chin, Sverrir Álafsson, Dian Nel, Problems and Solutions in Mathematical Finance Volume II - Equity Derivatives: 2 (The Wiley Finance Series) Hardcover – 3 February 2017			
11. Cornelis W Oosterlee, Lech A Grzelak, Mathematical Modeling Computation in Finance, World Scientific, ISBN 978-1-78634-794-7 ISBN 978-1-78634-805-0 (pbk), 2020			
12. Avishek Nag, Stochastic Finance with Python, Design Financial Models from Probabilistic Perspective, Apress, 2024. ISBN-13 (pbk): 979-8-8688-1051-			

ISBN-13 (electronic): 979-8-8688-1052-7. https://doi.org/10.1007/979-8-8688-1052-7
13. J. Cvitanic and F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, Prentice-Hall of India, 2007
14.. R.U. Seydel, Tools for Computational Finance, 5 th Edition, Springer, 2012
15. P. Glasserman, Monte Carlo Methods in Financial Engineering, Springer, 2004

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Programme		M.Sc. Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					III		
Course Code		Course Name		Credit Structure					Marks Distribution								
				L	T	P	C	INT	MID	END	Total	Bloom's taxonomy					
BS-5306		Generative Artificial Intelligence (Gen AI)		3	0	0	3	20	30	50	100						
Course Objectives		1. To know the concepts of Generative Artificial Intelligence 2. To know the applications of Generative Artificial Intelligence		Course Outcomes		CO1		Will learn concepts of Generative AI						Understanding/Comprehension			
						CO2		Will learn how the Generative AI is applied practically						Identify/Knowledge/Remember			
						CO3		Will get to know the connection between Mathematics and Generative AI						Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	

No.	Content	Hours	COs
I	Generative modeling – What is Generative Modeling – First Generative Modeling – Probability theory – Generative Taxonomy	6	CO1, CO2
II	Deep Learning – Data for Deep Learning – Deep Neural Network – Multilayer Perceptron – Convolutional Neural Network	8	CO1, CO2, CO3
III	Methods – Variational Autoencoders – Autoencoders – Variational autoencoders – Exploring the Latent Space	10	CO1, CO2, CO3
IV	Generative Adversarial Networks – Deep Convolutional GAN – Autoregressive Models – Normalizing Flow Models – Advanced topics (Optional)	16	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. David Foster, Generative Deep Learning, Teaching Machines to Paint, Write, Compose, and Play, O'Reilly, 2023			
2. Ian Goodfellow, Aaron Courville, Yoshua Bengio, Deep Learning, The MIT Press, 2016			
Reference Books			
1. Kevin Murphy, Probabilistic Machine Learning: An Introduction, The MIT Press, 2022			
2. Christopher M. Bishop Pattern Recognition and Machine Learning, Springer, 2006			
3. Deepak Kanungo, Probabilistic Machine Learning for Finance and Investing A Primer to Generative AI with Python, O'Reilly, 2023			
4. Ni Li, Yunqin Liu, Guanghong Gong, Luming Zhao, Haitao Yuan, A generative deep learning approach for real-time prediction of hypersonic vehicles in fluid-thermo-structural coupling fields, Aerospace Science and Technology 139 (2023) 108398. https://doi.org/10.1016/j.ast.2023.108398			



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CURRICULUM

Programme		M.Sc. Data Science								Academic Year of Regulation					2026-27		
Department		Basic and Applied Science								Semester					III		
Course Code		Course Name				Credit Structure					Marks Distribution						
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy			
BS-5307		Quantitative Finance Lab.				0	0	2	1	0	0	100	100				
Course Objectives		1. To know the concepts of Mathematical Finance 2. To implement the concepts of Mathematical Finance using computer.				Course Outcomes	CO1	Will learn concepts of Mathematical finance						Understanding/Comprehension			
							CO2	Will learn how the concepts in Mathematical finance work in real time scenario						Identify/Knowledge/Remember			
							CO3	Will get know how to convert the Mathematical framework to computational framework						Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											

SYLLABUS			
No.	Content	Hours	COs
I	Realization of Stochastic Processes with Python -Stochastic variables - Stochastic processes, Stochastic integration,	8	CO1, CO2
II	Programming Itô integral & Geometric Brownian motion asset price process	8	CO1, CO2, CO3
III	Simulating Black-Scholes Option Pricing Equation with Python - Black-Scholes model-Delta hedging under the Black-Scholes model	12	CO1, CO2, CO3
IV	Numerical implementation of Finite difference approach to pricing European options and American options, free-boundary problem; Monte-Carlo approach to pricing financial derivatives	12	CO1, CO2, CO3
Total Hours		40	
Text Books			
1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, 2 nd Edition, Springer, 2010			
2. D. Higham, Introduction to Financial Option Valuation: Mathematics, Stochastics and Computation, Cambridge University Press, 2004			
Reference Books			
1. Sankarshan Basu, John C. Hull, Options, futures and other derivatives, Pearson Education; 2022 & Series, Pearson Education			
2. Paul Wilmott, Introduces Quantitative Finance, Second Edition, Wiley; 2nd edition (29 June 2007)			
3. Siddhartha Pratim Chakrabarthy, Mathematical Finance: https://youtu.be/IrWeySxY9OA?list=PLwdnzlV3ogoV-4hbV6DP3BjdmjuaQPjcr			
4. Siddhartha Pratim Chakrabarthy, Mathematical Portfolio Theory: https://youtu.be/EU1atD847oQ?list=PLwdnzlV3ogoVZdKHNNaoVbcFDVo0Wb0am			
5. Anindya Goswami, https://www.youtube.com/playlist?list=PLEAYkSg4uSQ0Gmh0ozZ1nugWbuzSuuhqa			
6. Deepak Kanungo, Probabilistic Machine Learning for Finance and Investing A Primer to Generative AI with Python, O'Reilly, 2023			
7. J. Cvitanic and F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, Prentice-Hall of India, 2007			
8. R.U. Seydel, Tools for Computational Finance, 5 th Edition, Springer, 2012			
9. P. Glasserman, Monte Carlo Methods in Financial Engineering, Springer, 2004			



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CURRICULUM

Programme		M.Sc. Data Science								Academic Year of Regulation					2025-26		
Department		Basic and Applied Science								Semester					III		
Course Code		Course Name				Credit Structure					Marks Distribution					Bloom's taxonomy	
						L	T	P	C	INT	MID	END	Total				
BS-5308		Generative Artificial Intelligence (Gen AI) Lab.				3	0	2	1	0	0	100	100				
Course Objectives		1. To know the concepts of Generative Artificial Intelligence 2. To know the applications of Generative Artificial Intelligence				Course Outcomes	CO1	Will learn concepts of Generative AI						Understanding/Comprehension			
							CO2	Will learn how the Generative AI is applied practically						Identify/Knowledge/Remember			
							CO3	Will get to know the connection between Mathematics and Generative AI						Understanding/Analyzing			
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													

2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		
I	Program in Generative modeling – Generative Modeling – Probability theory – Generative Taxanomy												6	CO1, CO2		
II	Deep Learning illustration – Data for Deep Learning – Deep Neural Network – Multilayer Perceptron – Convolutional Neural Network												8	CO1, CO2, CO3		
III	Methods Programming – Variational Autoencoders – Autoencoders – Variational autoencoders – Exploring the Latent Space												10	CO1, CO2, CO3		
IV	Generative Adversarial Networks Applications with Programming – Deep Convolutional GAN – Autoregressive Models – Advanced topics												16	CO1, CO2, CO3		
Total Hours												40				
Text Books																
1. David Foster, Generative Deep Learning,Teaching Machines to Paint, Write, Compose, and Play, O’Reilly, 2023																
2. Ian Goodfellow, Aaron Courville, Yoshua Bengio, Deep Learning, The MIT Press, 2016																
Reference Books																
1. Kevin Murphy, Probabilistic Machine Learning: An Introduction, The MIT Press, 2022																
2. Christopher M. Bishop Pattern Recognition and Machine Learning, Springer, 2006																
3. Deepak Kanungo, Probabilistic Machine Learning for Finance and Investing A Primer to Generative AI with Python, O’Reilly, 2023																
4. Ni Li, Yunqin Liu, Guanghong Gong, Luming Zhao, Haitao Yuan, A generative deep learning approach for real-time prediction of hypersonic vehicles in fluid-thermo-structural coupling fields, Aerospace Science and Technology 139 (2023) 108398. https://doi.org/10.1016/j.ast.2023.108398																



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CURRICULUM

Programme		M.Sc. Data Science								Academic Year of Regulation				2026-27		
Department		Basic and Applied Science								Semester				IV		
Course Code		Course Name				Credit Structure					Marks Distribution					
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy		
BS-5401		Elective (Online or NPTEL or as faculty advisor)				4	0	0	4	20	30	50	100			
Course Objectives		TO BE SELECTED FROM THE LIST GIVEN FOR ELECTIVES				Course Outcomes	CO1							Understanding/Comprehension		
							CO2							Identify/Knowledge/Remember		
							CO3							Understanding/Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										

SYLLABUS			
No.	Content	Hours	COs
I			
II			
III			
IV			

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Programme		M.Sc. Data Science										Academic Year of Regulation				2026-27		
Department		Basic and Applied Science										Semester				I		
Course Code		Course Name				Credit Structure						Marks Distribution						
						L	T	P	C	INT	MID	END	Total	Bloom's taxonomy				
BS-5402		PROJECT / INTERNSHIP				0	0	0	10	0	0	100	100					
Course Objectives		TO BE DONE BY THE STUDENTS				Course Outcomes	CO1							Understanding/ Comprehension				
							CO2							Identify/ Knowledge/ Remember				
							CO3							Understanding/ Analyzing				
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		

1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content												Hours	COs		
I																
II																
III																
IV																

Elective Courses

	राष्ट्रीय प्रौद्योगिकी संस्थान अरुणाचल प्रदेश NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH (शिक्षा मंत्रालय, भारत सरकार के तहत राष्ट्रीय महत्व का संस्थान) (Institute of National Importance under Ministry of Education, Govt. of India)									CURRICULUM
Programme	M.Sc. Data Science					Academic Year of Regulation				2026-27
Department	Basic and Applied Science					Semester				
Course Code	Course Name	Credit Structure					Marks Distribution			
		L	T	P	C	INT	MID	END	Total	Bloom's taxonomy
BS22	Fluid dynamics	3	0	0	3	20	30	50	100	
Course Objectives	1. To learn about the about classical fluid dynamics	Course Outcomes	CO1	1. Will learn governing equations of fluid dynamics					Understanding/Comprehension	
	CO2		2. Will learn basic analytic solutions					Identify/Knowledge/Remember		
	CO3		3. Will learn basic coding for solving fluid flow problems					Understanding/		

														Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content													Hours	COs	
I	Features of viscous fluid Real and Ideal Fluids – Viscosity - Reynolds Number - Laminar and Turbulent Flows - Asymptotic Behaviour at Large Reynolds Numbers													4	CO1, CO2	
II	Fundamentals of Boundary–Layer Theory - Boundary–Layer Concept - Laminar Boundary Layer on a Flat Plate at Zero Incidence - Turbulent Boundary Layer on a Flat Plate at Zero Incidence - Fully Developed Turbulent Flow in a Pipe - Boundary Layer on an Airfoil Separation of the Boundary Layer													6	CO1, CO2, CO3	
III	Field Equations for Flows of Newtonian Fluids - Description of Flow Fields - Continuity Equation - Momentum Equation - General Stress State of Deformable Bodies - General State of Deformation of Flowing Fluids - Relation Between Stresses and Rate of Deformation - Stokes Hypothesis - Bulk Viscosity and Thermodynamic Pressure - Navier–Stokes Equations - Energy General Properties of the Equations of Motion - Similarity Laws - Similarity Laws for Flow with Buoyancy Forces (Mixed Forced and Natural Convection) - Similarity Laws for Natural Convection - Vorticity Transport Equation - Limit of Very Small Reynolds Numbers - Limit of Very Large Reynolds Numbers - Mathematical Example of the Limit $Re \rightarrow \infty$ - Non–Uniqueness of Solutions of the Navier–Stokes Equations													14	CO1, CO2, CO3	
IV	Exact Solutions of the Navier–Stokes Equations - Steady Plane Flows - Steady Axisymmetric Flows - Unsteady Plane Flows - Unsteady Axisymmetric Flows													6	CO1, CO2, CO3	
Total Hours													30			
Text Books																
1. Hermann Schlichting, Klaus Gersten, Boundary-Layer Theory, Springer, Ninth Edition, 2010																
2. Anatoly I. Ruban, Fluid Dynamics, Boundary layer theory, Part III, Oxford University Press, 2018																
Reference Books																
1. Sydney Goldstein, Modern Developments in Fluid Dynamics, Dover publications, Volume I, 1938																
2. Sydney Goldstein, Modern Developments in Fluid Dynamics, Dover publications, Volume II, 1965																
3. K. Stewartson, The Theory of Unsteady Laminar Boundary Layers, Advances in Applied Mechanics, Volume 6, 1960, Pages 1-37. https://doi.org/10.1016/S0065-2156(08)70109-1																

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Programme	M.Sc. Data Science					Academic Year of Regulation			2026-27	
Department	Basic and Applied Science					Semester				
Course Code	Course Name	Credit Structure					Marks Distribution			
		L	T	P	C	INT	MID	END	Total	Bloom's taxonomy
BS22	River modeling/Fluvial sedimentation modeling	3	0	0	3	20	30	50	100	
Course Objectives	1. To know the details of fluvial sedimentation 2. To impart the students about river dynamics	Course Outcomes	CO1	1. To understand the dynamics of sedimentation					Understanding/Comprehension	
			CO2	2. To model the dynamics of sedimentation					Identify/Knowledge/	

														Remember		
								CO3						3. To use programming technique in simulation of fluvial sedimentation		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1	3	2	1												
2	CO2	3	2	1												
3	CO3	3	3	3	3	1										
SYLLABUS																
No.	Content													Hours	COs	
I	Introduction - Physical Properties of Fluid and Sediment - Properties of Sediment Mixture - Properties of Fluid and Suspended Sediment Mixture - Terminal Fall Velocity of Sediment in Fluid													4	CO1, CO2	
II	Hydrodynamic Principles - Rates of Deformation - Conservation of Mass - Conservation of Momentum - Conservation of Energy - The Boundary Layer													10	CO1, CO2, CO3	
III	Turbulence in Open-Channel Flows - Decomposition and Averaging Procedure - Continuity Equation - Equation of Motion (Reynolds Equations) - Classical Turbulence Theories - Classification of Flow Field in Open Channels - Velocity Distribution													10	CO1, CO2, CO3	
IV	Sediment Threshold - Definition of Sediment Threshold - Threshold Velocity Concept - Lift Force Concept - Threshold Bed Shear Stress Concept Probabilistic Concept of Entrainment													6	CO1, CO2, CO3	
Total Hours													30			
Text Books																
1. Subhasish Dey, Fluvial Hydrodynamics, Hydrodynamic and Sediment Transport Phenomena, Springer, 2014																
Reference Books																



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Programme	M.Sc. Data Science					Academic Year of Regulation			2026-27		
Department	Basic and Applied Science					Semester					
Course Code	Course Name	Credit Structure					Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total		
BS22	Climate modeling	3	0	0	3	20	30	50	100		

Course Objectives		1 To teach the students fundamentals of climate Modeling. 2 To teach students to use data and computer program to understand climate modeling.					Course Outcomes		CO1	1. To learn about climate modeling.					Understanding/ Comprehe nsion		
									CO2	2. To learn how computer program can be used to advance climate modeling.					Identify/ Knowledge/ Remember		
									CO3	3. To learn programming used in climate mathematics.					Understanding/ Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs			
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
1	CO1	3	2	1													
2	CO2	3	2	1													
3	CO3	3	3	3	3	1											
SYLLABUS																	
No.	Content													Hours		COs	
I	Dimensional Analysis for Climate Science – Dimension and Units – Fundamental Dimensions – Dimensional Analysis – Estimating the Shock Wave Radius of a Nuclear Explosion by Dimensional Analysis													6		CO1, CO2	
II	Basics of R Programming - R tutorials – Define Sequence – Define Functions – Plot R – Symbolic Calculation – Vectors – Matrices – Simple Statistics – Basic Statistical methods for Climate Data Analysis – Climate Data Matrix and Linear Algebra - An SVD Representation Model for Space Time Data – SVD Oscillation Index – Mass Balance for Chemical Equations in Marine Chemistry													10		CO1, CO2, CO3	
III	Energy Balance Models for Climate – EBM for Modeling the Moon’s Surface Temperature – EBM for Global Average Surface Temperature of the Earth – Increasing the Complexity of Climate Models													8		CO1, CO2, CO3	
IV	Conservation Laws of Climate Dynamics – Conservation of Mass – Conservation of Momentum – Geostropic Approximation of the Momentum equations – The Potential Vorticity Conservation equation – Advanced R Analysis and Plotting – Global Data													6		CO1, CO2, CO3	
Total Hours													30				
Text Books																	
1. Samuel S. P. Shen, Richard C. J. Somerville, Climate Mathematics Theory and Applications, Cambridge University Press, 2019																	
2. Zhihua Zhang, John C. Moore, Mathematical and Physical Fundamentals of Climate Change, Elsevier, 2015																	
Reference Books																	
1. John B. Drake, Climate Modeling for Scientists and Engineers, SIAM, 2014																	

2. Serguei G. Dobrovolski, Stochastic Climate Theory, Models and Applications, Springer, 2000
3. W. S. B. Paterson, The Physics of Glaciers, Second edition, Elsevier, 2010

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Programme	M.Sc. Data Science					Academic Year of Regulation			2026-27		
Department	Basic and Applied Science					Semester					
Course Code	Course Name	Credit Structure					Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total		
MS22	Portfolio theory and Risk Management	3	0	0	3	20	30	50	100		
	1. To understand the advanced concepts of Mathematical Finance 2. To understand the implications of Portfolio		CO1	1. To learn Portfolio theory and Risk Management.				Understanding/Comprehe			

Course Objectives		theory and Risk Management in real life					Course Outcomes									nsion		
									CO2	2. To solve problems relevant to Portfolio theory and Risk Management.						Identify/ Knowledge/ Remember		
									CO3	3. To use programming and data analysis to understand Portfolio theory and Risk Management.						Understanding/ Analyzing		
No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs				
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3		
1	CO1	3	2	1														
2	CO2	3	2	1														
3	CO3	3	3	3	3	1												
SYLLABUS																		
No.	Content													Hours	COs			
I	Financial markets and instruments, risk-free and risky assets; Interest rates, present and future values of cash flows, term structure of interest rates, spot rate, forward rate; Bonds, bond pricing, yields, duration, convexity, term structure of interest rates;													4	CO1, CO2			
II	Asset pricing models, Cox-Ross-Rubinstein binomial model, geometric Brownian motion model; Financial derivatives, no-arbitrage principle; Forward and futures contracts and their pricing, hedging strategies using futures, interest rate and index futures;													6	CO1, CO2, CO3			
III	Swaps and its valuation, interest rate swaps, currency swaps; Options, general properties of options, trading strategies involving options; Discrete time pricing of European and American derivative securities by replication;													14	CO1, CO2, CO3			
IV	Continuous time pricing of European and American derivate securities by risk-neutral valuation; Finite difference approach to pricing European options and American options, free-boundary problem; Monte-Carlo approach to pricing financial derivatives.													6	CO1, CO2, CO3			
Total Hours													30					
Text Books																		
1. M. Capinski and T. Zastawniak, Mathematics for Finance: An Introduction to Financial Engineering, 2 nd Edition, Springer, 2010.																		
2. D. Higham, Introduction to Financial Option Valuation: Mathematics, Stochastics and Computation, Cambridge University Press, 2004.																		
Reference Books																		
1. J.C. Hull, Options, Futures and Other Derivatives, 10 th Edition, Pearson, 2018.																		

2. J. Cvitanic and F. Zapatero, Introduction to the Economics and Mathematics of Financial Markets, Prentice-Hall of India, 2007.
3. R.U. Seydel, Tools for Computational Finance, 5 th Edition, Springer, 2012.
4. P. Glasserman, Monte Carlo Methods in Financial Engineering, Springer, 2004.