Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	MT448	**Title of the Course**	Linear Algebra and Matrix Computations	**L**	**T**	**P**	**C**
Year	First	**Semester**	First	**3**	**1**	**0**	**4**
Pre-Requisite	Basic knowledge of Mathematics	**Co-requisite**	None				
Course Objectives	To introduce the basic concept of linear algebra. This course enables the students to understand the basic ideas of vector algebra, linear dependent and independent set and basis. Students of the course should master properties of matrices including how to use them to solve linear systems of equations and how they are used in linear transformations between vector spaces.						

Course Outcomes	
CO1	To develop the understanding of matrices, their various form as well their eigen values and vectors.
CO2	To learn the various methods to solve the simultaneous equations. To study the quadratic forms and related topics.
CO3	To understand the concepts of Vector spaces, their basis and dimensions.
CO4	To study the linear transformations, change of basis matrices and similar matrices.
CO5	To understand inner product spaces, orthonormal basis, diagonalization of symmetric matrices. Also to learn least square approximation.

Unit	**Topic**	**No. of Lectures**	**Mapped CO**
I	Algebra of matrices, Rank of Matrix and its Properties, Echelon matrix, Normal form, Row canonical form, Diagonal form, Triangular form, Inverse of a matrix, Product Form of Inverse, Partitioned matrices, Elementary matrices, Kronecker products, Eigen values and Eigen vectors, Cayley-Hamilton theorem.	8	1
II	**S**imultaneous linear equations, Gauss elimination method, Applications of System of Linear Equations, Gauss-Jordan-LU decomposition, Quadratic forms, Reduction and Classification of Quadratic forms, Definiteness and Related Results with Proofs.	8	2
III	Vector Spaces, Subspaces, Linear Combinations, Linear Dependence and Linear Independence, Spanning Set, Basis and Dimension of a Vector Space, Row Spaces, Column Spaces.	8	3
IV	Linear transformation, Null Spaces, The Matrix of a Linear Transformation, Rank Nullity Theorem, Change of Basis and Similar Matrices.	8	4
V	Inner-Product Spaces, Applications of Inner Product Spaces, Orthonormal basis, Orthogonal Projection, Gram-Schmidt Orthogonalization process. Diagonalization of Symmetric Matrices. Least-squares Problems, Applications of Least Square Approximation.	8	5

Suggested Readings:

Reference Books:

1. Gilbert Strang (2016): Introduction to linear algebra, 5/e., Wellesley-Cambridge.
2. David C. Lay (2019): Linear Algebra and Its Applications, Pearson, 5/e.
3. G. Allaire and S. M. Kaber (2008): Numerical Linear Algebra, Texts in Applied Mathematics, Springer.
4. Nick Fieller (2015):"Basics of Matrix Algebra for Statistics with R", CRC Press.

e-Learning Source:

1. https://nptel.ac.in/courses/111/105/111105112/
2. https://nptel.ac.in/courses/111/101/111101115/
3. https://nptel.ac.in/courses/111/106/111106135/

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1	2	1	3	3	1	2	3	2
CO2	3	1	2	1	2	1	3	3	1	2	3	2
CO3	3	1	1	1	2	1	3	2	1	2	3	2
CO4	3	1	1	1	2	1	3	2	1	2	3	2
CO5	3	1	1	1	2	1	3	2	1	2	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024 - 2025							
Course Code	MT449	**Title of the Course**	Statistical Methods for Data Science	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept of statistical Methods						

Course Outcomes	
CO1	Students will be able to understand the concept of concepts of statistical population and sample. Data: quantitative and qualitative, attributes, scales of measurement- nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives
CO2	Students will be able to understand the concept of Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis
CO3	Students will be able to understand the Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves
CO4	Students able to demonstrate the concepts of time series analysis.
CO5	Students will be able to understand the concept and applications of Theory of attributes: consistency of data, independence and association of attributes, measures of association and contingency

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, scales of measurement-nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives.	08	1
2		Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.	08	2
3		Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.	08	3
4		Characteristics of Time Series: the nature of time series data, time series statistical models, measures of dependence, stationary time series, estimation of correlation, vector-valued and multidimensional series, time series regression and exploratory data analysis: classical regression in the time series context, exploratory data analysis , smoothing in the time series context.	08	4
5		Theory of attributes: consistency of data, independence and association of attributes, measures of association and contingency.	08	5

Reference Books:

Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.

Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.

e-Learning Source: https://www.youtube.com/watch?v=WbKiJe5OkUU&list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa-6Gz

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2	2	3	3	3	3	3
CO2	3	2	3	2	2	2	2	3	3	3	3	2
CO3	3	3	2	2	3	3	2	3	3	3	3	3
CO4	2	3	3	3	3	2	1	3	3	3	3	2
CO5	2	2	3	3	3	2	2	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2021 - 2022							
Course Code	MT450	**Title of the Course**	Probability and Distribution Theory	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept of Probability and Distribution Theory						

Course Outcomes	
CO1	Students will be able to understand the concept of sample space, events, probability axioms, addition theorem of probability, conditional probability, multiplication theorem of probability, independent events and Baye's Theorem.
CO2	Students will be able to understand the concept of Random variable (r.v.) and functions of random variable, Distribution function and its properties, Mathematical expectation and moments, Probability generating function (PGF), moment generating function (MGF), and characteristic function (CF) and their interrelations.
CO3	Students will be able to understand the concept of Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial and Hyper geometric distribution
CO4	Students will be able to understand the concept of Continuous distributions: Uniform, Normal, Exponential, Gamma, Beta, Weibull, Pareto, Laplace, Lognormal, Logistic and Log-Logistic distribution.
CO5	Students will be able to understand the concept of Weak and strong law of large numbers, Statement and proof of central limit theorem and its applications, almost sure convergence, convergence in probability and distribution

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Fundamentals of Probability**	Basic concepts and definitions of probability, sample space, events, probability axioms, addition theorem of probability, conditional probability, multiplication theorem of probability, independent events and Baye's Theorem.	08	1
2	**Random Variables and Distribution Functions**	Random variable (r.v.) and functions of random variable, Distribution function and its properties, Mathematical expectation and moments, Probability generating function (PGF), probability transform and its application, moment generating function (MGF), and characteristic function (CF) and their interrelations.	08	2
3	**Discrete distributions**	Concept and applications of Discrete distributions: Uniform, Bernoulli, Binomial, Poisson, Geometric, Negative Binomial and Hyper geometric distribution	08	3
4	**Continuous distributions**	Concept and applications of Continuous distributions: Uniform, Normal, Exponential, Gamma, Beta, Weibull, Pareto, Laplace, Lognormal, Logistic and Log-Logistic distribution.	08	4
5	**Limit Theorems and Convergence**	Weak and strong law of large numbers, Statement and proof of central limit theorem and its applications, almost sure convergence, convergence in probability and distribution.	08	5

Reference Books:

1. Lehmann, F.L.(1986), Testing of Statistical Hypothesis (Student edition).
2. Hogg, R.V. and Craig, A.T. (1978), Introduction to Mathematical Statistics, Fourth
edition, Colliar Mac.Millan Publishers.
3. Mood, A.M., Graybill, F.F. and Boes, D.C. (1974), Introduction to the Theory of

e-Learning Source:

https://www.youtube.com/watch?v=be9e-Q-jC-0

https://www.youtube.com/watch?v=bQ5_PPRPjG4

https://www.youtube.com/watch?v=jauhoR7w1YM

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	3	3	2	1	3	3	3	3	3
CO2	3	3	3	2	3	2	2	3	3	3	3	2
CO3	2	3	2	3	3	2	3	3	3	3	3	3
CO4	2	3	3	1	2	2	1	3	3	3	3	3
CO5	3	2	1	2	3	2	1	3	3	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2019-20							
Course Code	**CS-518**	**Title of the Course**	**Soft Computing**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	**I**	**3**	**1**	**0**	**4**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	**The course curriculum helps to understand the concepts of fuzzy rule, fuzzy data, crisp rule, crisp data, fuzzy relation, implication, and elaborates the concepts of particle intelligence, swarm intelligence, evolutionary computing, optimalization theory, different kind of neural network, learning theory by neural network, algorithm-based computing, probabilistic computing, hybrid system concepts, etc.**						

Course Outcomes	
CO1	Know about the concepts of fuzzy logic, crisp logic, fuzzy relation, fuzzy implication rule
CO2	Know about the concepts of optimization theory genetic computing, and evolutionary computing.
CO3	Know about the concepts of the neural network, Single Layer, Multilayer, classifications, Implementation, and training
CO4	Know about the concepts of classifications, Implementation, and training
CO5	Know about the concept of hybrid systems, like neuro-fuzzy systems, fuzzy genetic systems, and particle intelligence.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction of soft computing:**	Introduction of soft computing: [8] What is Soft Computing, soft computing vs. hard computing, soft computing paradigms, and applications of soft computing. Basics of Machine Learning. Dealing with Imprecision and Uncertainty- Probabilistic Reasoning- Bayesian network, Pearl's Scheme for Evidential Reasoning, Dempster-Shafer Theory for Uncertainty Management, Certainty Factor Based Reasoning	8	1
2	**Neural Networks**	Neural Networks: Basics of Neural Networks- Neural Network Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, characteristics and applications of ANN, McCulloch Pitt model, different activation functions, Supervised Learning algorithms- Perceptron (Single Layer, Multi-layer), Linear separability, ADALINE, MADALINE, RBF networks , Widrow Hoff, learning rule, Delta learning rule, Back Propagation algorithm, Un-Supervised Learning algorithms- Hebbian Learning, Winner take all, Self-Organizing Maps, Adaptive Resonance Theory: Architecture, classifications, Implementation and training. Associative Memory	8	2
3	**Fuzzy Logic:**	Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions, Fuzzy rule base system: fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, Mamdani Fuzzy Models – Sugeno Fuzzy Models, Adaptive Neuro-Fuzzy Inference Systems Architecture	8	3
4	**Optimization**	Derivative-based Optimization – Descent Methods – The Method of Steepest Descent – Classical Newton's Method, Simulated Annealing, Random Search, Downhill Simplex Search Derivative-free Optimization- Genetic algorithm Fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, mutation operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional methods.	8	4
5	**Evolutionary Computing**	Evolutionary Computing: Genetic programming (GP), Ant colony optimization (ACO), Particle swarm optimization (PSO), Artificial Immune System (AIS).	8	5

Reference Books:

1. S, Rajasekaran& G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications", PHI Publication.
2. S.N. Sivanandam& S.N. Deepa, "Principles of Soft Computing", Wiley Publications.
3. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India.
4. SAndries P Engelbrecht, Computational Intelligence: An Introduction, Wiley Publications.

e-Learning Source:

https://archive.nptel.ac.in/courses/106/105/106105173

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2019-20							
Course Code	**CS 519**	**Title of the Course**	**SOFT COMPUTING LAB**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	**I**	**0**	**0**	**2**	**2**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	• **Artificial Intelligence, Various types of production systems, characteristics of production systems.** • **Neural Networks, architecture, functions and various algorithms involved.** • **Fuzzy Logic, Various fuzzy systems and their functions.** • **Genetic algorithms, its applications and advances.**						

Course Outcomes	
CO1	1. Learn about soft computing techniques and their applications
CO2	2. Analyze various neural network architectures
CO3	3. Understand perceptrons and counter propagation networks.
CO4	4. Define the fuzzy systems
CO5	5. Analyze the genetic algorithms and their applications.

Sr. No.	**List of Experiments**	**Contact Hrs.**	**Mapped CO**
1	Exposure to Scilab Script &Functions.	2	1
2	Write a program for Recursion in Scilab.	2	1
3	Write a program in Scilab for decision control and loops.	2	2
4	Write a program in Scilab for surface plots	2	2
5	Write a program in Scilab for File Handling.	2	2
6	Find whether the given matrix is (a) reflexive (b) tolerance and (c) transitivity matrix or not by writing a Scilab program.	2	3
7	Find whether the given matrix is symmetry or not by writing a Scilab program.	2	3
8	Write a program in Scilab to calculate union, intersection, complement and difference of two fuzzy sets	2	3
9	Find the fuzzy relation between two vectors R and S, using max–product and max-min method by writing a Scilab program.	2	4
10	Illustrate different types of generalized bell membership functions using Scilab program	2	4
11	Design networks of McCullochPittsneurons that implement logical NOT, AND and OR gates. Draw each network and label all the weight and threshold values	2	4
12	Write a program of Perceptron Training Algorithm.	2	5
13	Write a program to implement delta rule.	2	5
14	Write a Scilab program for Hebbnetto classify two-dimensional input pattern sbi polar with their targets given „*" indicates a „+1" and „. " Indicates „-1".	2	5
15	Implement Classical Genetic Algorithm in Scilab	2	5
16	Write a Scilab program for Linear & Quadratic optimization.	2	5

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	1	1	1	1	1	3	3	-	-
CO2	3	3	3	3	3	3	3	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	3	3	1	1	1	1	3	-	2	-
CO4	**3**	3	3	3	3	1	1	1	1	1	1	3	3	-	-
CO5	**3**	3	3	3	3	**-**	1	-	1	1	1	3	3	-	2

1-Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024 - 2025							
Course Code	MT451	**Title of the Course**	Regression analysis and predictive modeling	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	**4**
Pre-Requisite	Knowledge of Mathematics	**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept of Regression analysis and predictive modeling						

Course Outcomes	
CO1	Students will be able to understand the concept of Simple linear regression, estimating the coefficients, accuracy of the coefficient estimates, model accuracy.
CO2	Students will be able to understand the concept of Multiple linear regression: regression coefficients, qualitative Predictors, comparison of linear regression with K-Nearest Neighbours
CO3	Students will be able to understand the Generalized linear models: logistic regression, estimating the regression coefficients, multiple logistic regression, logistic regression for >2 response classes, linear discriminant analysis, quadratic discriminant analysis, naïve Bayes, Poisson regression
CO4	Students will be able to understand the concept Model diagnostics: residuals, comparing models, cross validations: validation set approach, leave-one-out cross-validation, k-fold cross-validation. Bootstrap, Tree-based method: Basics, Regression Trees, Classification Trees, Trees versus Linear Models, Advantages and disadvantages of Trees.
CO5	Students will be able to understand the concept Regularization: subset selection, shrinkage methods, reduction methods, Elastic net, Bayesian shrinkage, non-linear least squares, model selection.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Simple linear regression, estimating the coefficients, accuracy of the coefficient estimates, model accuracy.	08	1
2		Multiple linear regression: regression coefficients, qualitative Predictors, comparison of linear regression with K-Nearest Neighbours.	08	2
3		Generalized linear models: logistic regression, estimating the regression coefficients, multiple logistic regression, logistic regression for >2 response classes, linear discriminant analysis, quadratic discriminant analysis, naïve Bayes, Poisson regression.	08	3
4		Model diagnostics: residuals, comparing models, cross validations: validation set approach, leave-one-out cross-validation, k-fold cross-validation. Bootstrap, Tree-based method: Basics, Regression Trees, Classification Trees, Trees versus Linear Models, Advantages and disadvantages of Trees.	08	4
5		Regularization: subset selection, shrinkage methods, reduction methods, Elastic net, Bayesian shrinkage, non-linear least squares, model selection.	08	5

Reference Books:

Cook, R.D. and Weisberg, S.: Residual and Influence in Regression. Chapman and Hall.

Draper, N.R.and Smith, H.: Applied Regression Analysis, Wiley.

Gunst, F. and Mason, R.L.: Regression analysis and its Applications - A Data Oriented Aproach. Marcel and Dekker.

e-Learning Source:

https://www.youtube.com/watch?v=OQV8WmUdeIo&list=PLbMVogVj5nJSpj5sl-8tdKARg1lw2wEa-

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2	2	3	3	3	3	3
CO2	3	2	3	2	2	2	2	3	3	3	3	2
CO3	3	3	2	2	3	3	2	3	3	3	3	3
CO4	2	3	3	3	3	2	1	3	3	3	3	2
CO5	2	2	3	3	3	2	2	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024 - 2025							
Course Code	MT452	**Title of the Course**	Sampling techniques and testing of hypothesis	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite	Basics of probability and its distribution	**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept of Sampling techniques and testing of hypothesis						

Course Outcomes	
CO1	Students will be able to understand the concept of sample and population, complete enumeration versus sampling, sampling and non sampling errors, requirements of a good sample, simple random sampling with and without replacement, estimates of population mean, total and proportion, variances of these estimates, and estimates of theses variances and sample size determination
CO2	Students will be able to understand the concept of Stratified random sampling, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Systematic Sampling, estimates of population mean and total, variances of these estimates
CO3	Students will be able to understand the Ratio and regression methods of estimation, estimates of population mean and total (for SRS of large size), variances of these estimates and estimates of theses variances, variances in terms of correlation coefficient between X and Y for regression method and their comparison with SRS
CO4	Students will be able to understand the concept of statistical hypothesis, Hypothesis testing, Test based on Z, t, F, Chi-square test, goodness of fit, test of independence, test for correlation and test for dispersion. Confidence limits and confidence intervals
CO5	Students will be able to understand the concept of ANOVA: one way and two way ANOVA. Non-parametric tests: Sign test, signed rank test, Kolmogrov-Smirnov test, Test of independence (run test). Two sample problem tests: Wilcoxon Mann-Whitney test, Median test, Kolmogrov-Smirnov test, run test

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Concept of sample and population, complete enumeration versus sampling, sampling and non sampling errors, requirements of a good sample, simple random sampling with and without replacement, estimates of population mean, total and proportion, variances of these estimates, and estimates of theses variances and sample size determination.	08	1
2		Stratified random sampling, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Systematic Sampling, estimates of population mean and total, variances of these estimates.	08	2
3		Ratio and regression methods of estimation, estimates of population mean and total (for SRS of large size), variances of these estimates and estimates of theses variances, variances in terms of correlation coefficient between X and Y for regression method and their comparison with SRS.	08	3
4		Concept of statistical hypothesis, Hypothesis testing, Test based on Z, t, F, Chi-square test, goodness of fit, test of independence, test for correlation and test for dispersion. Confidence limits and confidence intervals.	08	4
5		ANOVA: one way and two way ANOVA. Non-parametric tests: Sign test, signed rank test, Kolmogrov-Smirnov test, Test of independence (run test). Two sample problem tests: Wilcoxon Mann-Whitney test, Median test, Kolmogrov-Smirnov test, run test.	08	5

Reference Books:

1. Sampling techniques: W.G. Cochran, Wiley
2. Sampling methodologies and applications: P.S.R.S. Rao, Chapman and Hall/CRC 2000
3. Elements of sampling theory and methods: Z. Govindrajalu, Prentice Hall, 1999
4. Sampling: P. Mukhopadhyaya, Prentice Hall of India, 1998.

e-Learning Source: https://www.youtube.com/watch?v=OTVk28caCxw&list=PLFW6lRTa1g83WMISEL7xm1W9pAir5W0ZM

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2	2	3	3	3	3	3
CO2	3	2	3	2	2	2	2	3	3	3	3	2
CO3	3	3	2	2	3	3	2	3	3	3	3	3
CO4	2	3	3	3	3	2	1	3	3	3	3	2
CO5	2	2	3	3	3	2	2	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024 - 2025							
Course Code	MT453	**Title of the Course**	Bayesian Techniques	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**3**	**1**	**0**	
Pre-Requisite		**Co-requisite**					
Course Objectives	The course objective is to learn the basic concept Statistical inference						

Course Outcomes	
CO1	Students will be able to understand the concept of Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), RaoBlackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators
CO2	Students will be able to understand the concept of Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Baye's estimators
CO3	Students will be able to understand the probability and inference. single-parameter models, introduction to multi-parameter models, asymptotic and connections to non-Bayesian approaches, hierarchical models.
CO4	Students will be able to understand Bayesian data analysis, model checking, evaluating, comparing, and expanding models, posterior predictive checking, graphical posterior predictive checks, evaluating, comparing, and expanding models, information criteria and cross-validation, model comparison based on predictive performance, model expansion
CO5	Students will be able to understand the Introduction to Bayesian computation, Markov chain Monte Carlo simulations, Gibbs sampler, Metropolis and Metropolis-Hastings algorithms, convergence of chains, Effective number of simulation draws, Hamiltonian Monte Carlo, Hamiltonian dynamics for a simple hierarchical model with STAN

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Estimation: Concepts of estimation, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), RaoBlackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications).	08	1
2		Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Baye's estimators.	08	2
3		Fundamentals of Bayesian Inference: probability and inference. single-parameter models, introduction to multi-parameter models, asymptotic and connections to non-Bayesian approaches, hierarchical models.	08	3
4		Fundamentals of Bayesian data analysis, model checking, evaluating, comparing, and expanding models, posterior predictive checking, graphical posterior predictive checks, evaluating, comparing, and expanding models, information criteria and cross-validation, model comparison based on predictive performance, model expansion.	08	4
5		Bayesian computation: Introduction to Bayesian computation, Markov chain Monte Carlo simulations, Gibbs sampler, Metropolis and Metropolis-Hastings algorithms, convergence of chains, Effective number of simulation draws, Hamiltonian Monte Carlo, Hamiltonian dynamics for a simple hierarchical model with STAN.	08	5

Reference Books:

Bhat, B. R (1981): Modern Probability Theory, Wiley Eastern Ltd., New Delhi.

Rohatgi, V. K. (1988): An Introduction to Probability and Mathematical Statistics, Wiley, Eastern Limited.

C. R. Rao: Linear statistical inference and its applications, John Wiley and sons Inc.

Halmous. Paul. R: Measure Theory, Springer.

e-Learning Source:

https://www.youtube.com/watch?v=iin6vthyzsQ&list=PLbMVogVj5nJRkNUH5v9qNEJvW7r2A7rEY

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	2	3	2	2	3	3	3	3	3
CO2	3	2	3	2	2	2	2	3	3	3	3	2
CO3	3	3	2	2	3	3	2	3	3	3	3	3
CO4	2	3	3	3	3	2	1	3	3	3	3	2
CO5	2	2	3	3	3	2	2	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Integral University, Lucknow

Effective from Session: 2024 - 2025							
Course Code	MT 454	**Title of the Course**	Data Analytics using SPSS	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	**0**	**0**	**6**	
Pre-Requisite		**Co-requisite**					
Course Objectives	The objective is to train the students in statistical data analysis using SPSS software package in real life problems						

Course Outcomes	
CO1	Students will be practically able to understand the concept of Introduction to SPSS: Layout of SPSS, data editor window, data files, import and export of data files, defining variables, data and variable views, entry, recoding, computing new variables, selection of cases, splitting and merging of files, working with multiple data sources.
CO2	Students will be practically able to understand the Analyzing Data, Frequencies, descriptive statistics, percentile ranks for a single/multiple variables, Measures of central tendency for single/multiple groups, standard scores, bar charts, histograms, pie chart, scatter plots and box plots, Summarize, Means, OLAP Curves.
CO3	Students will be practically able to understand the concept of Pearson correlation coefficient, Spearman correlation coefficient, Partial Correlation, Distances, simple linear regression, multiple linear regression. Testing of Hypothesis: Parametric tests; Single sample t test, Independent samples t test, paired t test.
CO4	Students will be practically able to understand the procedure of One way ANOVA, Factorial ANOVA, Repeated Measures ANOVA, Analysis of Covariance, multiple comparison test. *Cronbach's alpha* test, Test – retest Reliability
CO5	Students will be practically able to understand the concept of Nonparametric tests; chi square goodness of fit, chi square test for independence, run test for randomness, Kruskal Wallis Test Sign Test, Mann Whitney U test, Wilcoxon signed-rank test sign test for location, median test, Kolmogorov-Smirnov test - one and two sample problems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Introduction to SPSS: Layout of SPSS, data editor window, data files, import and export of data files, defining variables, data and variable views, entry, recoding, computing new variables, selection of cases, splitting and merging of files, working with multiple data sources.	08	1
2		Analyzing Data, Frequencies, descriptive statistics, percentile ranks for a single/multiple variables, Measures of central tendency for single/multiple groups, standard scores, bar charts, histograms, pie chart, scatter plots and box plots, Summarize, Means, OLAP Curves.	08	2
3		Pearson correlation coefficient, Spearman correlation coefficient, Partial Correlation, Distances, simple linear regression, multiple linear regression. Testing of Hypothesis: Parametric tests; Single sample t test, Independent samples t test, paired t test.	08	3
4		One way ANOVA, Factorial ANOVA, Repeated Measures ANOVA, Analysis of Covariance, multiple comparison test. *Cronbach's alpha* test, Test – retest Reliability	08	4
5		Nonparametric tests; chi square goodness of fit, chi square test for independence, run test for randomness, Kruskal Wallis Test Sign Test, Mann Whitney U test, Wilcoxon signed-rank test sign test for location, median test, Kolmogorov-Smirnov test - one and two sample problems	08	5

Reference Books:

John MacInnes, An Introduction to Secondary Data Analysis with IBM SPSS Statistics, Sage.

MarijaNorusis, The SPSS Guide to Data Analysis.

Stephen A. Sweet, and Karen Grace-Martin, Data Analysis with SPSS: A First Course in Applied Statistics, Pearson.

Pallant, Julie,SPSS Survival Manual, McGraw-Hill.

Cronk, Brian, How to Use SPSS: A Step-By-Step Guide to Analysis and Interpretation, Pyrczak Publishing

Landau S. and Everitt B.S., A handbook of Statistical Analysis using SPSS, Chapman & Hall.

Cleophas T.J. and Zwinderman A.H., SPSS for Starters, Springer

e-Learning Source:

https://www.youtube.com/watch?v=U18BD4jqz5g

https://www.youtube.com/watch?v=TZPyOJ8tFcI

https://www.youtube.com/watch?v=6rgwgwv8qdA

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CO3	3	1	1	1	1	1	3	3	3	3	3	3
CO4	3	1	1	1	2	1	3	3	3	3	3	3
CO5	3	1	1	1	1	1	3	3	3	3	3	3

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