

MAZHARUL ULOOM COLLEGE (AUTONOMOUS)

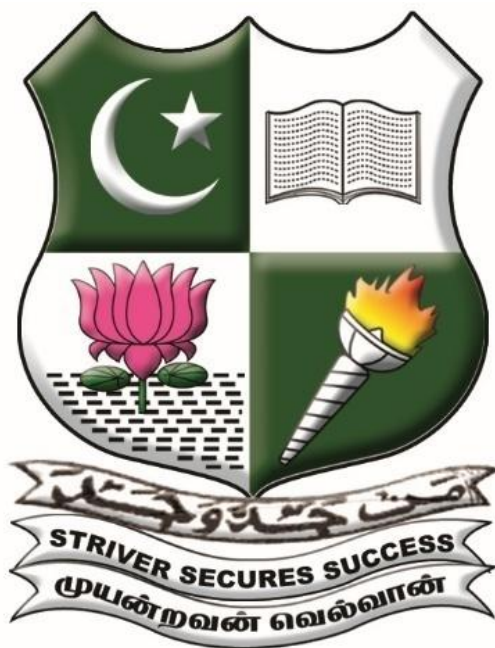
(Established & Managed by the Ambur Muslim Educational Society)

Accredited by NAAC with Grade “A” CGPA 3.23 in Cycle 3

Affiliated to Thiruvalluvar University, Vellore

Ambur - 635802 (Tirupattur District)

Department of Mathematics



COURSE STRUCTURE & SYLLABUS

for the programme

B. Sc (Mathematics)

(Students admitted from year 2025-2026 onwards)

MAZHARUL ULOOM COLLEGE (Autonomous)

Affiliated to the Thiruvalluvar University

AMBUR – 635 802

Department of Mathematics

BOARD OF STUDIES FOR B.Sc., MATHEMATICS

Composition

S. No.	Designation	Name and Details
1.	Chairman	Mr. P. Markandan, M.Sc., M.Phil., B.Ed., SLET, Associate Professor and Head, Department of Mathematics, Mazharul Uloom College (Autonomous), Ambur. Cell: 9894769873 e-mail id: pm@mucollege.ac.in
2.	University Nominee	Dr. S. Kasthuri, M.Sc., M.Phil., Ph.D., Associate Professor & Head, Dept of Mathematics, Auxilium College (Autonomous) Katpadi, Vellore. Cell: 9488043687 e-mail id: kasthuri1795@gmail.com
3.	Subject Experts	Dr. M. Pitchaimani, M.Sc. M.Phil., Ph.D., School Chairperson, Director and Head i/c, Ramanujan Institute for Advanced Study in Mathematics, University of Madras, Chennai. Cell:9952792396 e-mail id: mpitchaimani@unom.ac.in
4.		Dr. M. S. Jagadeesh Kumar, MSc, M.Phil, M.Tech (IT) Ph.D. Professor and Head, Department of Mathematics, School of Advanced Sciences, Vellore Institute of Technology (VIT), Vellore. Cell: 9952188371 e-mail id: msjagadeesh@vit.ac.in
5.	Corporate Representative	Mr. Baburaj Sathiyamoorthy, M.C.A., Manager-Operation Excellence, Healthcare and Life Sciences, Cognizant Technology Solutions, Elcot, Sholinganallur, Chennai. Cell: 9751238622 e-mail id: baburaj.sathiyamoorthy@cognizant.com
6.	Meritorious Alumnus	Dr. A. Akilbasha, M.Sc., M.Phil., Ph.D., Assistant Professor, Department of Mathematics and Statistics, Dr. Vishwanathkarad MIT World Peace University, Pune 411038, Maharashtra Cell: 7200497688 e-mail id: akilhusha.a@mitwpu.edu.in
7.	Members (Staff)	Mr. I. SyedAbuthahir, M.Sc., M. Phil., Assistant Professor, Department of Mathematics, Mazharul Uloom College (Autonomous), Ambur. Cell: 7397155409 e-mail id: thahirmuc@gmail.com
8.		Mrs. M. Parveen Banu, M.Sc., M. Phil, N.E.T., Assistant Professor, Department of Mathematics, Mazharul Uloom College (Autonomous), Ambur. Cell: 9884358007 e-mail id: parveenriasm@gmail.com

9.	Dr. R. Jothilakshmi, M.Sc., M.Phil., M.Tech. (IT)., Ph.D., Assistant Professor, Department of Mathematics Mazharul Uloom College (Autonomous), Ambur. Cell: 9894948094 e-mail id: jothilakshmiphd@gmail.com
10.	Mr. P. M.Mudassirur Rahman, M.Sc.,M. Phil., N.E.T., Assistant Professor, Department of Mathematics, Mazharul Uloom College, Ambur. Cell: 8144382332 e-mail id: pmr@mucollege.ac.in
11.	Mr. S. J. Rafeeq Ahmed, M.Sc.,M. Phil., Assistant Professor, Department of Mathematics, Mazharul Uloom College, Ambur. Cell: 8122575430 e-mail id: sjr@mucollege.ac.in

Introduction

B.Sc (Mathematics)

Mathematics is the study of quantity, structure, space and change, focusing on problem solving, with wider scope of application in science, engineering, technology, social sciences etc. The key core areas of study in Mathematics include Algebra, Analysis (Real & Complex), Differential Equations, Geometry, and Mechanics. The Bachelor's Degree B.Sc. Mathematics is awarded to the students on the basis of knowledge, understanding, skills, attitudes, values and academic achievements expected to be acquired by learners at the end of the Programme. Learning outcomes of Mathematics are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for gaining knowledge of Mathematics.

Bachelor's degree in Mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of Mathematics. This also leads to study of related areas like Computer science, Financial Mathematics, Statistics and many more. Thus, this programme helps learners in building a solid foundation for higher studies in Mathematics. The skills and knowledge gained have intrinsic aesthetics leading to proficiency in analytical reasoning. This can be utilised in Mathematical modelling and solving real life problems.

Students completing this programme will be able to present Mathematics clearly and precisely, make abstract ideas precise by formulating them in the language of Mathematics, describe Mathematical ideas from multiple perspectives and explain fundamental concepts of Mathematics to non-Mathematicians.

Completion of this programme will also enable the learners to join teaching profession, enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

Program Outcomes (POs)	
PO Code	Program Outcome Statement
PO1	Disciplinary Knowledge: Acquire detailed knowledge and expertise in all the disciplines of the subject.
PO2	Communication Skills: Ability to express thoughts and ideas effectively in writing, listening and confidently communicate with others using appropriate media.
PO3	Critical Thinking: Students will develop aptitude, Integrate skills of analysis, critiquing, application and creativity.
PO4	Analytical Reasoning: Familiarize to evaluate the reliability and relevance of evidence, collect, analyze and interpret data.
PO5	Problem Solving: Capacity to extrapolate the learned competencies to solve different kinds of non-familiar problems.
PO6	Information/digital literacy: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
PO7	Lifelong Learning: Engage in lifelong learning and work on career enhancement and adapt to changing personal, professional and societal needs.

Program Specific Outcomes (POs)	
PSO Code	Program Specific Outcome Statement
PSO1	Gain strong knowledge of mathematical and statistical concepts to analyse and solve theoretical and practical problems.
PSO2	Develop skills to understand, build, and present logical mathematical arguments and apply quantitative reasoning in various fields.
PSO3	Respect diverse ideas and nurture critical thinking, problem-solving, decision-making, and leadership for innovation and entrepreneurship.
PSO4	Adapt to emerging trends by gaining skills in data science, artificial intelligence, and machine learning.
PSO5	Build analytical, computational, and communication skills to enhance employability, pursue higher studies, and contribute to society.

Level	Definition	Key Actions
K1: Remembering	Ability to recall or recognize facts, terms, basic concepts, or answers without necessarily understanding them.	Retrieve, Memorize, Repeat, Define, Identify, Recognize
K2 : Understanding	Comprehending the meaning of information, interpreting or translating knowledge into your own words.	Explain, Describe, Summarize, Interpret, Paraphrase
K3: Applying	Using knowledge in new situations, such as solving problems or applying theories to real-world situations.	Use, Demonstrate, Implement, Calculate, Practice
K4: Analyzing	Breaking information into parts to explore understandings and relationships; identifying motives or causes.	Compare, Contrast, Categorize, Distinguish, Examine, Organize
K5: Evaluating	Making judgments based on criteria and standards, often involving checking and critiquing.	Judge, Critique, Justify, Assess, Prioritize, Recommend
K6: Creating	Putting elements together to form a new coherent whole or original product.	Design, Develop, Invent, Compose, Construct, Generate

Department of Mathematics

SYLLABUS AND SCHEME OF EXAMINATIONS UPTO IV SEMESTER

The course comprises of

- | | | | |
|---------------------------------|------------|---|--|
| (i) Foundation Course | : Part-I | : Tamil / Urdu | |
| | : Part-II | : English | |
| (ii) Core Courses | : Part-III | : Main Subjects / Allied Subjects | |
| | | Electives | |
| (iii) Skill Enhancement Courses | : Part-IV | : Skill Development Courses | |
| (iv) Extension Services | : Part-V | : All students have to study Value | |
| | | Education / Moral Instruction, | |
| | | Environmental Studies and enroll for | |
| | | NSS, NCC, SPORTS, YRC, or any other service organizations | |
| | | in the college. | |

Sem	Course Code	Part	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
							CIA	ESE	
Semester I		I	Language – I	Language – I	6	3	25	75	100
		II	English - I	English – I	6	3	25	75	100
		III	Core - I	Algebra and Trigonometry	5	5	25	75	100
			Core - II	Differential Calculus	5	5	25	75	100
			Elective – I	Numerical Methods -I	4	3	25	75	100
				Financial Mathematics					
		IV	Skill Enhancement Course – I (SEC - I)	Mathematics for Competitive Examinations – I	2	2	25	75	100
			Fundamental Course	Bridge Mathematics	2	2	25	75	100
	Total				30	23			700
Semester II		I	Language – II	Language-II	6	3	25	75	100
		II	English – II	English-II	6	3	25	75	100
		III	Core – III	Integral Calculus	5	5	25	75	100
			Core – IV	Analytical Geometry (2D & 3D)	5	5	25	75	100
			Elective – II	Numerical Methods -II	4	3	25	75	100
				Industrial Mathematics					
		IV	Skill Enhancement Course – II (SEC - II)	Mathematics for Competitive Examinations – II	2	2	25	75	100
			Skill Enhancement Course – III (SEC - III)	Office Automation	2	2	25	75	100
		Total				30	23		

Sem	Course Code	Part	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
							CIA	ESE	
Semester III		I	Language – III	Language – III	6	3	25	75	100
		II	English - III	English – III	6	3	25	75	100
		III	Core – V	Differential Equations and Laplace transforms	4	4	25	75	100
			Core – VI	Vector Analysis	4	4	25	75	100
			Elective – III	Mathematical Statistics – I	4	4	25	75	100
				Number Theory					
		IV	Skill Enhancement Course – IV (SEC - IV)	Introduction to Data Science	2	2	25	75	100
			Skill Enhancement Course – V (SEC - V)	Geogebra – Transforming Mathematics with Technology (Practical)	2	2	25	75	100
		V	EVS	Environmental Studies	2	1	25	75	100
	Total				30	23			800
Semester IV		I	Language – IV	Language – IV	6	3	25	75	100
		II	English – IV	English – IV	6	3	25	75	100
		III	Core – VII	Fourier Series and Fourier Transformation	5	4	25	75	100
			Core – VIII	Statics	5	4	25	75	100
			Elective – IV	Mathematical Statistics – II	3	3	25	75	100
				Practical - Mathematical Statistics	1	1	25	75	100
				Special Functions	4	4	25	75	100
		IV	Skill Enhancement Course – VI (SEC - VI)	Introduction to AI	2	2	25	75	100
			Skill Enhancement Course – VII (SEC - VII)	R – Programming (Practical Only)	2	2	25	75	100
		Total				30	22		

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		Core V	4	4	25	75	100
Course Title		DIFFERENTIAL EQUATIONS AND LAPLACE TRANSFORMS					

Learning Objectives

L01	Develop a strong foundation in first-order and higher-degree ordinary differential equations and their standard solution techniques.
L02	Develop proficiency in solving second-order linear differential equations with constant and variable coefficients using appropriate analytical methods.
L03	Understand and apply methods for solving simultaneous, total, and simultaneous total differential equations.
L04	Develop competency in using Laplace and inverse Laplace transforms for solving linear and simultaneous differential equations.
L05	Develop an understanding of the formation and solution of first-order partial differential equations using standard methods.

SYLLABUS

Unit	Contents	Hours
I	Ordinary Differential Equations Linear Equation - Bernoulli Equation – Equations of First order and Higher degree: Equations solvable for p, Equations solvable for x and Equations Solvable for y – Clairaut's Equation - Exact Differential Equations – Equations Reducible to Exact Equations.	12
II	Ordinary Differential Equations [Contd...] Second Order Linear Differential Equations with Constant Coefficients for finding the P.I's of the form e^{ax} , $\sin ax$, $\cos ax$, x^n and $e^{ax} V$, where V is $\sin(mx)$ or $\cos(mx)$ or x^n – Method of Variation of Parameters for second order LDE - LDE with variable coefficients - Cauchy's homogeneous Linear Equations – Legendre's Linear Equations.	12
III	Differential Equations of Other Types Simultaneous Equations with Constant coefficients – Total Differential Equations Simultaneous Total Differential Equations – Equations of the form $dx/P = dy/Q = dz/R$	12
IV	Laplace Transform Transform – Definition and condition for existence – Properties – Laplace Transform of Standard functions – First shifting theorem and Applications – Laplace transform of derivatives and Integrals – Inverse Laplace Transform – Properties – Inverse Laplace transform by partial fractions - Application of Laplace Transform to solution of first and second order Linear Differential equations [with constant coefficients] including simultaneous equations.	12
V	Partial Differential Equations Formation of PDE – Solution of First order PDE - Complete Integral – Particular Integral – Singular Integral – Linear Equations of the first order – Nonlinear Equations of the first Order: Types: $f(p,q) = 0$, $f(x,p,q) = 0$, $f(y, p, q) = 0$, $f(z, p, q) = 0$, $f(x, q) = f(y, p)$, $z = px+qy + f(p, q)$ - Equations Solvable by direct Integration.	12

Recommended Textbook(s):

1. P. Duraipandian and Kayalal Pachaiyappan, Vector Analysis, S. Chand & Co. Ltd.

Reference Book(s):

1. M.D. Raisinghania, Vector Calculus, S. Chand & Company, New Delhi.
2. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Co., New Delhi.
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

Web Resource(s):

<https://nptel.ac.in/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply appropriate techniques to solve first-order and higher-degree ordinary differential equations, including linear, Bernoulli, Clairaut, exact, and reducible-to-exact equations.	K3, K4
CO2	Apply suitable methods to solve second-order linear differential equations with constant and variable coefficients, including variation of parameters, Cauchy's homogeneous equations, and Legendre's equations.	K3, K4
CO3	Analyze simultaneous equations with constant coefficients, total differential equations, simultaneous total differential equations, and equations of the form $\left(\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}\right)$.	K3, K4
CO4	Apply Laplace and inverse Laplace transform techniques, including properties, shifting theorem, transforms of derivatives and integrals, and partial fractions, to solve linear and simultaneous differential equations.	K3, K4
CO5	Apply appropriate methods to form and solve first-order partial differential equations, including complete, particular, and singular integrals, linear and nonlinear equations, and equations solvable by direct integration.	K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO2	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO3	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO4	3	1	3	3	3	2	1	3	3	2	2	3	2.42
CO5	3	1	3	3	3	1	1	3	3	2	1	3	2.25
Mean Overall Score													2.25
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		Core VI	4	4	25	75	100
Course Title		VECTOR ANALYSIS					

Learning Objectives

LO1	Develop a fundamental understanding of vector point functions and the principles of vector differentiation.
LO2	Develop proficiency in applying vector differential operators such as gradient, divergence, curl, and the Laplacian operator.
LO3	Develop the ability to evaluate line, surface, and volume integrals and solve related problems.
LO4	Understand and apply vector identities and their use in vector calculus problems.
LO5	Develop competency in applying Gauss Divergence, Stokes', and Green's theorems to appropriate vector calculus problems.

SYLLABUS

Unit	Contents	Hours
I	Vector Differentiation – Basics: Vector point function – Scalar point function – Derivative of a vector and derivative of a sum of vectors – Derivative of a product of a scalar and a vector point function – Derivative of a scalar product and vector product.	12
II	Vector Differential Operators: The vector operator 'del' – The gradient of a scalar point function – Divergence of a vector – Curl of a vector – Solenoidal and irrotational vectors – Simple applications.	12
III	Laplacian Operator and Line Integrals: Laplacian operator – Vector identities – Line integral – Simple problems.	12
IV	Surface and Volume Integrals: Surface integral – Volume integral – Applications.	12
V	Integral Theorems: Gauss Divergence Theorem – Stokes' Theorem – Green's Theorem in two dimensions.	12

Recommended Textbook(s):

1. P. Duraipandian and Kayalal Pachaiyappan, Vector Analysis, S. Chand & Co. Ltd.

Reference Book(s):

1. M.D. Raisinghania, Vector Calculus, S. Chand & Company, New Delhi.
2. Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Co., New Delhi.
3. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

Web Resource(s):

<https://nptel.ac.in/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply the rules of vector differentiation to vector point functions, scalar products, and vector products.	K3
CO2	Apply gradient, divergence, curl, and Laplacian operators to scalar and vector point functions and identify solenoidal and irrotational vectors.	K1, K3
CO3	Calculate line, surface, and volume integrals and solve related problems using appropriate techniques.	K3
CO4	Analyze vector identities and their relationships in problems involving vector differential and integral operations.	K4
CO5	Apply Gauss Divergence, Stokes's, and Green's theorems to evaluate and solve problems involving vector integrals.	K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO4	3	1	3	3	3	1	1	3	3	3	1	3	2.33
CO5	3	1	3	3	3	1	1	3	3	2	1	3	2.25
Mean Overall Score													2.25
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \ \& \ \leq 2$	Medium
$>2 \ \& \ \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		Elective III	4	4	25	75	100
Course Title		MATHEMATICAL STATISTICS – I					

Learning Objectives

LO1	Develop a comprehensive understanding of fundamental probability concepts, including axioms, conditional probability, independence, and Bayes' theorem.
LO2	Develop proficiency in understanding discrete and continuous random variables, distribution functions, mathematical expectation, variance, and covariance.
LO3	Develop an understanding of generating functions and probability inequalities for studying the properties of random variables.
LO4	Develop the ability to analyze relationships between variables using correlation and regression techniques.
LO5	Develop familiarity with important discrete and continuous standard probability distributions and their characteristics.

SYLLABUS

Unit	Contents	Hours
I	Probability Theory: Axiomatic approach to probability – Theorems on probability – Conditional Probability – Multiplication theorem – Independent events – Bayes' Theorem. [Chapter 3–4]	12
II	Random Variables and Mathematical Expectation: Random Variables (Discrete and Continuous) – Distribution Function – Mathematical Expectation – Expected value of functions – Properties of expectation – Properties of variance – Covariance. [Chapter 5–6]	12
III	Generating Functions: Moment generating function – Characteristic Function – Uniqueness and Inversion Theorem (Statement only) – Chebyshev's Inequality – Simple problems. [Chapter 7]	12
IV	Correlation and Regression: Bivariate Distribution – Correlation – Karl Pearson's Coefficient of Correlation – Rank Correlation – Linear Regression. [Chapter 10–11]	12
V	Standard Distributions: Discrete: Binomial, Poisson, Hyper Geometric, Negative Binomial. Continuous: Normal, Uniform, Exponential distributions. [Chapters 8–9]	12

Recommended Textbook(s):

1. S.C. Gupta & V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, June 2002.

Reference Book(s):

1. Hogg R.V. & Craig A.T. (1998), Introduction to Mathematical Statistics, Macmillan.
2. Mood A.M., Graybill F.A. & Boes D.G. (1974), Introduction to Theory of Statistics, McGraw Hill.
3. Snedecor G.W. & Cochran W.G. (1967), Statistical Methods, Oxford and IBH.
4. Hoel P.G. (1971), Introduction to Mathematical Statistics, Wiley. Publications.
5. Vittal, P. R. (2004). Mathematical statistics. Margham Publications.
6. Kapur, J. N & Saxena, H. C. (2010). Mathematical statistics (20th ed.). S. Chand & Company Ltd.

Web Resource(s):

<https://nptel.ac.in>
<https://mathworld.wolfram.com/topics/ProbabilityandStatistics.html>
<https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2014/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply axiomatic probability, conditional probability, multiplication theorem, independence, and Bayes' theorem to solve probability problems.	K1, K2, K3
CO2	Calculate distribution functions, mathematical expectations, variance, and covariance for discrete and continuous random variables.	K1, K2, K3
CO3	Apply moment generating functions, characteristic functions, and Chebyshev's inequality to solve problems involving random variables.	K1, K2, K3
CO4	Analyze bivariate distributions and determine correlation and regression relationships using Karl Pearson's coefficient, rank correlation, and linear regression.	K2, K3, K4
CO5	Apply appropriate discrete and continuous standard probability distributions to solve probability problems.	K1, K2, K3

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO4	3	1	3	3	3	1	1	3	3	3	2	3	2.42
CO5	3	1	3	3	3	1	1	3	3	2	2	3	2.33
Mean Overall Score													2.3
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \ \& \ \leq 2$	Medium
$>2 \ \& \ \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		Elective III	4	4	25	75	100
Course Title		NUMBER THEORY					

Learning Objectives

LO1	Develop a strong understanding of divisibility properties of integers, greatest common divisors, the Euclidean algorithm, and Diophantine equations.
LO2	Develop an understanding of prime numbers, their distribution, the Fundamental Theorem of Arithmetic, and methods related to prime generation and conjectures.
LO3	Develop proficiency in applying the theory and properties of congruences, including linear congruences, the Chinese Remainder Theorem, and classical theorems in number theory.
LO4	Develop an understanding of important number-theoretic functions, including divisor functions, Möbius inversion, and the greatest integer function.
LO5	Develop knowledge of Euler's Phi-function, Euler's theorem, and their relationship with Fermat's theorem and properties of the Phi-function.

SYLLABUS

Unit	Contents	Hours
I	Divisibility Theory in the integers: The Division Algorithm- The Greatest Common Divisor - The Euclidean Algorithm-The Diophantine Equation $ax+by=c$.	12
II	Primes and Their Distribution: The Fundamental theorem of Arithmetic- The Sieve of Eratosthenes- The Goldbach Conjecture	12
III	The Theory of Congruences -Basic Properties of Congruence -Linear Congruences and The Chinese Remainder Theorem-Fermat's Little Theorem and Pseudoprimes - Wilson's Theorem.	12
IV	Number Theoretic Functions: The Sum and Number of Divisors-The Mobius Inversion Formula-The Greatest Integer Function.	12
V	Euler's generalization of Fermat's Theorem: Euler's Phi-function- Euler's Theorem-Some properties of the Phi-function	12

Recommended Textbook(s):

David M. Burton, Elementary Number Theory, Seventh Edition, Tata McGraw Hill, 2023.

1. UNIT I Chapter 2 Sections 2.2-2.5
2. UNIT II Chapter 3 Sections 3.1-3.3
3. UNIT III Chapter 4 Sections 4.2, 4.4 Chapter 5 Sections 5.2, 5.3
4. UNIT IV Chapter 6 Sections 6.1-6.3
5. UNIT V Chapter 7 Sections 7.2-7.4

Reference Book(s):

1. G. H. Hardy, An Introduction to the Theory of Numbers, Oxford University Press; 6th edition, 2008.
2. Joseph Silverman, A Friendly Introduction to Number Theory, Pearson Education; Fourth edition, 2019.
3. Kumaravelu S., Susheela Kumaravelu, Elements of Number Theory, S.K.V Publishers, Nagercoil, 2002.

Web Resource(s):

1. <https://youtube.com/playlist?list=PLmxCweM-UENwd0YFTrzSwvHaOiV3R9mZ&si=dPHWTJLz7gVrxXme>
2. <https://youtube.com/playlist?list=PLBlnK6fEyqRjjeHdm0cwu6E-nhhEluuVA&si=onlSE5ddSuRF982Q>
3. https://youtube.com/playlist?list=PLlj41Lsfa1mZ4OYASMq5D_EYtW27ZgQI3&si=6YVILqDFHQOX Eumf

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply the Division Algorithm, Euclidean Algorithm, greatest common divisor, and Diophantine equations to solve problems involving integers.	K1, K2, K3
CO2	Analyze the properties and distribution of prime numbers using the Fundamental Theorem of Arithmetic, Sieve of Eratosthenes, and related concepts.	K1, K2, K3, K4
CO3	Apply congruence properties, linear congruences, the Chinese Remainder Theorem, Fermat's Little Theorem, Wilson's Theorem, and concepts of pseudoprimes to solve number-theoretic problems.	K1, K2, K3
CO4	Calculate and analyze number-theoretic functions involving divisors, Möbius inversion, and the greatest integer function.	K1, K2, K3, K4
CO5	Apply Euler's Phi-function and Euler's theorem to solve problems and analyze properties of the Phi-function.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	1	1	3	3	3	2	3	2.42
CO4	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO5	3	1	3	3	3	1	1	3	3	2	2	3	2.33
Mean Overall Score													2.28
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		SEC IV	2	2	25	75	100
Course Title		INTRODUCTION TO DATA SCIENCE					

Learning Objectives

LO1	Develop a foundational understanding of Data Science, its lifecycle, applications, data sources, data types, and commonly used data formats.
LO2	Develop proficiency in applying descriptive and inferential statistical techniques for analyzing and interpreting data.
LO3	Develop the ability to measure data proximity, identify different types of outliers, and understand appropriate outlier detection approaches.
LO4	Develop competency in assessing data quality and performing data cleaning, missing-value treatment, and data wrangling operations.
LO5	Develop skills in transforming, reducing, exploring, and visually representing data using appropriate statistical and visualization techniques.

SYLLABUS

Unit	Contents	Hours
I	Introduction to Data Science & Data Formats Introduction to Data Science - The 3 V's: Volume, Velocity, Variety - Need and Importance: Why Learn Data Science? - Applications of Data Science across domains - The Data Science Lifecycle and Data Scientist's Toolbox. Types of Data: Structured, Semi-structured, and Unstructured Data - Challenges and problems with Unstructured Data - Data Sources: Open Data, Social Media Data, Multimodal Data, and Standard Datasets - Data Formats: Integers, Floats, Text Data, Text Files, Dense Numerical Arrays, Compressed or Archived Data - File Formats: CSV, JSON, XML, HTML, Tar, GZip, Zip files, and Image Files (Rasterized, Vectorized, and Compressed).	6
II	Statistical Data Analysis — Descriptive & Inferential Foundations Role of Statistics in Data Science - Descriptive Statistics: Measuring Frequency, Central Tendency (Mean, Median, Mode), and Dispersion (Range, Standard Deviation, Variance, Interquartile Range) - Inferential Statistics: Principles of Hypothesis Testing, Multiple Hypothesis Testing, and Parameter Estimation Methods.	6
III	Data Proximity & Outlier Analysis Measuring Data Similarity and Dissimilarity: Data Matrix versus Dissimilarity Matrix -Proximity Measures for Nominal Attributes and Binary Attributes (Symmetric and Asymmetric) Distance Metrics for Numeric Data: Euclidean Distance, Manhattan Distance, and Minkowski Distance - Proximity Measures for Ordinal Attributes Concept of Outliers - Types of Outliers: Global (Point) Outliers, Contextual Outliers, and Collective Outliers; Outlier Detection Methods (Supervised, Unsupervised, and Semi-supervised).	6
IV	Data Objects, Data Quality, Cleaning & Wrangling Data Objects and Attribute Types (Nominal, Binary, Ordinal, Numeric, Discrete vs. Continuous) - Importance of Data Quality and Reasons for Pre-processing - Data Wrangling and Missing Value Imputation - Cleaning Noisy Data: Handling Duplicates, NULLs, Out-of-date Data, Extra Whitespaces, Inconsistent Delimiters, and Datetime Issues.	6
V	Data Transformation, Reduction & Visualization Data Transformation: Rescaling, Normalizing, Binarizing, Standardizing, Label Encoding, and One Hot Encoding - Data Reduction and Discretization: Binning, Histograms, and Concept Hierarchies - Exploratory Data Analysis (EDA) and Visual Encoding - Basic Charts: Histograms, Bar Charts, Scatter Plots, Line Charts, Pie Charts, and Donut Charts - Specialized & Advanced Tools: Boxplots, Heat Maps, Treemaps, Wordclouds, and Geospatial Maps.	6

Recommended Textbook(s):	
1. Dr. Ms. Manisha Bharambe and Dr. Mrs. Harsha Patil, Foundations of Data Science, 2nd Edition, Nirali Prakashan, 2022. ISBN: 978-93-5451-187-5.	
Reference Book(s):	
1. Joel Grus, Data Science from Scratch: First Principles with Python, 2nd Edition, O'Reilly Media, 2019. ISBN: 978-1492041139. 2. Cathy O'Neil and Rachel Schutt, Doing Data Science: Straight Talk from the Frontline, O'Reilly Media, 2013. ISBN: 978-1449358655. 3. Peter Bruce, Andrew Bruce, and Peter Gedeck, Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python, 2nd Edition, O'Reilly Media, 2020. ISBN: 978-1492072942. 4. Jake VanderPlas, Python Data Science Handbook: Essential Tools for Working with Data, 2nd Edition, O'Reilly Media, 2022. ISBN: 978-1098121228. 5. Jiawei Han, Micheline Kamber, and Jian Pei, Data Mining: Concepts and Techniques, 3rd Edition, Morgan Kaufmann, 2011. ISBN: 978-0123814791.	
Web Resource(s):	
https://nptel.ac.in/	

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain the Data Science lifecycle, applications, data types, data sources, and commonly used data and file formats.	K1, K2
CO2	Apply descriptive and inferential statistical techniques, including measures of central tendency, dispersion, hypothesis testing, and parameter estimation, to analyze data.	K1, K2, K3, K4
CO3	Calculate appropriate proximity and distance measures and analyze different types of outliers using suitable detection approaches.	K1, K2, K3, K4
CO4	Apply data cleaning and wrangling techniques to handle missing values, duplicates, NULLs, noisy data, inconsistent formats, and datetime issues.	K2, K3, K4
CO5	Apply data transformation, reduction, discretization, exploratory data analysis, and visualization techniques to prepare and represent data effectively.	K2, K3, K4, K6

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	3	2	3	2	2	3	3	2.5
CO2	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO3	3	1	3	3	3	3	2	3	3	2	3	3	2.67
CO4	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO5	3	2	3	3	3	3	2	3	3	3	3	3	2.83
Mean Overall Score													2.7
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		SEC V	2	2	25	75	100
Course Title		GEOGEBRA – TRANSFORMING MATHEMATICS WITH TECHNOLOGY (PRACTICAL)					

Learning Objectives	
LO1	Develop foundational proficiency in using GeoGebra for mathematical exploration, visualization, and manipulation of matrices.
LO2	Develop the ability to visualize and solve trigonometric functions, identities, and equations using GeoGebra.
LO3	Develop competency in solving polynomial equations and investigating their roots, factors, maxima, and minima.
LO4	Develop an understanding of limits and continuity through graphical and computational approaches using GeoGebra.
LO5	Develop the ability to apply mathematical concepts and GeoGebra-based techniques to real-world problems involving projectile motion, cost functions, and data modeling.

SYLLABUS		
Unit	Contents	Hours
I	Introduction to GeoGebra and Matrices: Introduction to GeoGebra and its applications – Exploring the GeoGebra interface – Creating and manipulating matrices – Matrix operations (addition, multiplication) – Rank and Transpose – Inverse of a matrix.	6
II	Trigonometry and GeoGebra: Trigonometric functions and identities – Graphing trigonometric functions – Using GeoGebra to solve trigonometric equations – Trigonometric applications.	6
III	Roots of Polynomials: Solving polynomial equations – Graphical representation – Finding roots and factors – Maxima and Minima of polynomial equations.	6
IV	Limits and Continuity: Introduction to limits and their graphical representation – Calculating limits – Exploring continuity – Real-world scenarios.	6
V	Advanced Topics and Practical Applications: Real-world Application: Projectile Motion - Real-world scenario: Cost function limit - Data Modeling Case Study	6

Recommended Resources:
1. Online GeoGebra Documentation and tutorials (https://www.geogebra.org). 2. GeoGebra Software: Latest version downloadable free from the GeoGebra website. 3. Course Materials: Lecture notes, slides, and assignments provided by the instructor.
Web Resource(s):
https://spoken-tutorial.org https://swayam.gov.in (Applications of GeoGebra)

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply GeoGebra tools to create, manipulate, and perform operations on matrices, including addition, multiplication, transpose, rank, and inverse.	K1, K2, K3

C02	Apply trigonometric functions, identities, graphs, and GeoGebra techniques to solve trigonometric equations and related problems.	K1, K2, K3
C03	Analyze polynomial equations using graphical methods to determine roots, factors, maxima, and minima.	K2, K3, K4
C04	Calculate and analyze limits and continuity using graphical and computational approaches.	K2, K3, K4
C05	Apply mathematical and GeoGebra-based techniques to solve real-world problems involving projectile motion, cost function limits, and data modeling.	K3, K4, K6

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
C01	3	1	3	3	3	3	2	3	3	2	2	3	2.58
C02	3	1	3	2	3	3	2	3	3	2	2	3	2.5
C03	3	1	3	3	3	3	2	3	3	2	2	3	2.58
C04	3	1	3	3	3	3	2	3	3	2	2	3	2.58
C05	3	2	3	3	3	3	2	3	3	3	3	3	2.75
Mean Overall Score													2.62
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \ \& \ \leq 2$	Medium
$>2 \ \& \ \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Core VII	5	4	25	75	100
Course Title		FOURIER SERIES AND FOURIER TRANSFORMATION					

Learning Objectives

LO1	Develop a comprehensive understanding of Fourier series, periodic functions, and the conditions for representing functions using Fourier series.
LO2	Develop proficiency in constructing Fourier series for different intervals, including odd, even, and half-range expansions, and applying RMS and Parseval's formula.
LO3	Develop competency in applying Fourier integral representations and Fourier transform techniques to functions and their transformations.
LO4	Develop proficiency in applying inverse Fourier transforms, convolution, sine and cosine transforms, and Parseval's formula.
LO5	Develop an understanding of Z-transforms and their inverse techniques and apply them to solve difference equations.

SYLLABUS

Unit	Contents	Hours
I	Fourier Series Definition – Periodic Functions - Trigonometric Fourier Series – Diriclet's Conditions for expansion of Fourier series with periodicity 2π , intervals of the form $[c, c + 2\pi]$ – Odd and Even Functions – Half range series in $[0, \pi]$	15
II	Fourier Series (Cont.) Change of interval – Periodicity $2l$ - intervals of the form $[c, c + 2l]$ – Odd and Even functions – Half range series intervals of the form in $[0, l]$ – root mean square value (RMS value) - Parseval's Formula.	15
III	Fourier Transforms Fourier integral Theorem (statement only) – Fourier integral representation – sine and cosine integrals –Infinite Fourier Transform – Properties – Linearity, Change of Scale, Modulation – simple problems.	15
IV	Fourier Transforms (Cont.) Inverse Fourier Transforms – Properties – Convolution of Fourier Transforms – Properties – sine and cosine transforms – properties – Parseval's Formula – self reciprocals	15
V	Z transforms Z transforms : Definition and properties – Problems – inverse Z transforms – inverse transforms by using partial fractions, Residues method – solution of Difference equations.	15

Recommended Textbook(s):

1. Erwin Kreyszig (2011), Advanced Engineering Mathematics, John Wiley & Sons, Inc. (10th edition), Printed in the United States of America

Reference Book(s):

1. P.R.Vittal. (2004) Vector Calculus, Fourier series and Fourier Transform. Margham Publications, Chennai.
2. B.S.Grewal (2012). Higher Engineering Mathematics, Khanna Publishers(42nd edition), Nai Sarak, New Delhi.
3. S.J.Venkatesan, Vector Analysis, and Fourier Analysis, Sri Krishna Publications, Chennai.

Web Resource(s):

<https://ocw.mit.edu/courses/18-085-computational-science-and-engineering-i-fall-2008/resources/lecture-28-fourier-series-part-1/>
<https://www.classcentral.com/course/edx-differential-equations-fourier-series-andpartial-differential-equations-11763>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply Dirichlet's conditions and Fourier series techniques to represent periodic functions, including odd, even, and half-range functions.	K1, K2, K3
CO2	Calculate Fourier series for functions over different intervals and determine RMS values using Parseval's formula.	K1, K2, K3
CO3	Apply Fourier integral representations and Fourier transform properties, including linearity, change of scale, and modulation, to solve problems.	K1, K2, K3
CO4	Apply inverse Fourier transforms, convolution, sine and cosine transforms, and Parseval's formula to solve transform-related problems.	K1, K2, K3, K4
CO5	Apply Z-transform and inverse Z-transform techniques, including partial fractions and residues, to solve difference equations.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	2	1	3	3	2	2	3	2.42
CO4	3	1	3	3	3	2	1	3	3	2	2	3	2.42
CO5	3	1	3	3	3	2	1	3	3	2	2	3	2.42
Mean Overall Score													2.33
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \ \& \ \leq 2$	Medium
$>2 \ \& \ \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Core VIII	5	4	25	75	100
Course Title		STATICS					

Learning Objectives

L01	Develop a fundamental understanding of forces acting on particles and the principles governing their resultant and equilibrium.
L02	Develop proficiency in analyzing forces, moments, couples, and equivalent force systems acting on rigid bodies.
L03	Develop the ability to analyze coplanar force systems, moments, couples, and equilibrium conditions for rigid bodies.
L04	Develop competency in reducing coplanar force systems and applying the laws of friction to solve equilibrium and friction-related problems.
L05	Develop proficiency in determining the center of mass of particles, rods, laminas, arcs, and solid bodies using appropriate analytical and integration methods.

SYLLABUS

Unit	Contents	Hours
I	Forces on a Particle Forces – Types of forces – Resultant of three forces related to triangle acting at a point – Resultant of several forces acting on a particle – Equilibrium of a particle under three forces – Equilibrium of a particle under several forces (Chapter 2 :Sections 2.1, 2.2 ; Chapter 3 : Sections 3.1)	15
II	Forces on a Rigid body Moment of a force – General motion of a rigid body – Equivalent system of forces – Parallel forces – Forces along the sides of the triangle – Couples (Chapter 4 : Sections 4.1 to 4.6)	15
III	Forces on a Rigid body (Cont.) Resultant of several coplanar forces - Moment of a certain couple as an area - Couples in a parallel planes - Resultant of a couple and a force - Equation of the line of action of the resultant - Sum of the moments about an arbitrary point - Equilibrium of a rigid body under three coplanar forces - contangent formulae (Chapter 4 : Sections 4.7 to 4.9)	15
IV	Specific Reduction of Forces and Friction Reduction of coplanar forces into a force and couple – Friction – Laws of friction – Cone of friction and angle of friction – Applications involving frictional forces (Chapter 5 : Sections 5.1, 5.2 (excluding 5.2.1))	15
V	Center of Mass Center of mass – Center of mass of a triangular lamina – Three particles of same mass – Three particles of certain masses – Uniform rods forming a triangle – Lamina in the form of a trapezium and solid tetrahedron – Center of mass using integration – Circular arc – Circular lamina – Elliptic lamina – Solid hemisphere – Solid right circular cone – Hemispherical shell – Hollow right circular cone – Cardioid lamina. (Chapter 6 : Sections 6.1,6.2,6.2.1, 6.2.2)	15

Recommended Textbook(s):

1. P.Duraipandian, Laxmi Duraipandian, Muthamizh Jayapragasam, Mechanics, 6-e, S.Chand and Company Ltd., 2005

Reference Book(s):

1. V.Dharmapadam, Statics, S.Viswanathan Pvt.Ltd., Madras, 1974.
2. R.C.Hibbler, Engineering Mechanics, Statics and Dynamics, Macmillan Publishing Company.
3. S.L.Loney, Principle of mechanics, Macmillan and Company Ltd., 1969

4. T.K.Manichavachagam Pillai and Narayanan, Statics, The National Publishing company, Madras 1961
5. T.Natarajan, T.Govinda Rajan, G.R.Venkataraman, K.Muthuswamy, Statics, Rochoose and sons, Madras, Chand and Company Ltd., New Delhi 1970.
6. S.Narayan, R.Hanumantha Rao, K.Sitaraman, P.Kandaswamy, Statics, S.c.

Web Resource(s):

<http://mathworld.wolfram.com>

<https://www.e-booksdirectory.com/details.php?ebook=6650>

<https://ocw.mit.edu/courses/8-223-classical-mechanics-ii-january-iap-2017/pages/lecture-notes/>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply principles of force systems to determine resultants and analyze the equilibrium of particles under three or several forces.	K1, K2, K3, K4
CO2	Calculate moments and couples and analyze equivalent systems of forces and parallel forces acting on rigid bodies.	K1, K2, K3, K4
CO3	Analyze coplanar force systems, couples, moments, and equilibrium conditions of rigid bodies under three coplanar forces.	K1, K2, K3, K4
CO4	Apply force-reduction techniques and the laws of friction to solve problems involving coplanar forces and frictional forces.	K1, K2, K3, K4
CO5	Calculate the center of mass of particles, rods, laminas, arcs, and solid bodies using appropriate analytical and integration techniques.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO4	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO5	3	1	3	3	3	2	1	3	3	2	1	3	2.33
Mean Overall Score													2.27
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective IV	3	3	25	75	100
Course Title		MATHEMATICAL STATISTICS – II					

Learning Objectives

LO1	Develop a comprehensive understanding of sampling theory, sampling distributions, standard errors, and important probability distributions used in statistical inference.
LO2	Develop proficiency in formulating and conducting statistical tests of significance for large and small samples.
LO3	Develop an understanding of the principles and methods of point estimation, including desirable properties of estimators and estimation techniques.
LO4	Develop competency in evaluating statistical tests using power, the Neyman–Pearson approach, likelihood ratio tests, and most powerful tests.
LO5	Develop proficiency in applying Analysis of Variance and principles of experimental design to one-way and two-way classifications and standard experimental designs.

SYLLABUS

Unit	Contents	Hours
I	Sampling Theory: Population and statistics – Large and small samples – sampling errors - Parameter and Statistics – Sampling Distribution -Standard Error – Student's t, chi-square and F distributions – Relationship between t, F and chi-square distributions. [Chapter 12]	9
II	Tests of Significance: Null and Alternate Hypothesis – Type I and Type II error - Large sample tests for proportion, mean, and standard deviation – small sample tests based on t, Chi-square and F statistics – Tests of independence of attributes – Goodness of fit tests. [Chapter 13]	9
III	Point Estimation: Unbiasedness, consistency, efficiency, sufficiency – Cramer–Rao Inequality – Maximum Likelihood Estimation – Method of Moments – t, F, and Z distributions. [Chapter 14]	9
IV	Power of the test – Neyman– Pearson Lemma – Likelihood Ratio Test – Most Powerful Test (Statement only). [Chapters 15–16]	9
V	Analysis of Variance and Design of Experiments: ANOVA – One-way and Two-way Classification – Basic Principles: Randomization, Replication, Local Control – CRD, RBD, and Latin Square Design. [Chapters 17–18]	9

Recommended Textbook(s):

1. S.C. Gupta & V.K. Kapoor, Elements of Mathematical Statistics, 3rd revised edition, Sultan Chand & Sons.

Reference Book(s):

1. Hogg R.V. & Craig A.T. (1998), Introduction to Mathematical Statistics, Macmillan.
2. Mood A.M., Graybill F.A. & Boes D.G. (1974), Introduction to Theory of Statistics, McGraw Hill.
3. O. Kempthorne, Design of Experiments.
4. Das and Giri, Design of Experiments, Wiley Eastern.
5. Vittal, P. R. (2004). Mathematical statistics. Margham Publications.
6. Kapur, J. N & Saxena, H. C. (2010). Mathematical statistics (20th ed.). S. Chand & Company Ltd.

Web Resource(s):

<https://nptel.ac.in>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply sampling theory and sampling distributions to determine standard errors and work with Student's (t), chi-square, and (F) distributions.	K1, K2, K3
CO2	Apply appropriate large- and small-sample tests of significance to test hypotheses concerning means, proportions, standard deviations, independence of attributes, and goodness of fit.	K1, K2, K3, K4
CO3	Analyze the properties of estimators, including unbiasedness, consistency, efficiency, and sufficiency, and apply Maximum Likelihood and Method of Moments estimation techniques.	K1, K2, K3, K4
CO4	Analyze the power of statistical tests and apply the Neyman–Pearson Lemma and Likelihood Ratio Test to identify appropriate testing procedures.	K1, K2, K3, K4
CO5	Apply ANOVA and experimental design principles to analyze one-way and two-way classifications and implement CRD, RBD, and Latin Square Designs.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	3	3	2	1	3	3	2	2	3	2.42
CO2	3	1	3	3	3	2	1	3	3	3	3	3	2.58
CO3	3	1	3	3	3	2	1	3	3	2	3	3	2.5
CO4	3	1	3	3	3	2	1	3	3	3	3	3	2.58
CO5	3	1	3	3	3	2	1	3	3	3	3	3	2.58
Mean Overall Score													2.53
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$> 1 \text{ \& } \leq 2$	Medium
$> 2 \text{ \& } \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective Practical	1	1	25	75	100
Course Title		Practical – Mathematical Statistics					

Learning Objectives

L01	Understand the methods of collection, classification, and presentation of statistical data using tables, diagrams, and graphs.
L02	Apply techniques to compute and interpret measures of central tendency and dispersion, including coefficient of variation.
L03	Analyze relationships between variables using correlation and regression methods.
L04	Apply theoretical probability distributions and use the method of least squares for curve fitting.
L05	Perform statistical hypothesis testing using chi-square tests and analyze variance using ANOVA and experimental design methods.

SYLLABUS

Unit	Contents	Hours
I	Collection and Presentation of Statistical Data : Construction of Uni-variate frequency distribution – Diagrammatic and Graphical Representation of Statistical Data (Histogram, Multiple bar diagram, sub-divided bar diagram, percentage bar diagram, pie diagram, Frequency polygon, Frequency curve , Ogives curve and Lorenz curve).	3
II	Measures of Central Tendency and Dispersion Computation of Measures of Central Tendency – Computation of Measures of Dispersion (absolute and relative measures) – Coefficient of Variation.	3
III	Correlation and Regression Computation of Karl Pearson’s Coefficient of Correlation and Spearman’s Rank Correlation Coefficient–Regression equation (two variables only).	3
IV	Theoretical Distributions and Methods of Least Squares: Fitting of Binomial, Poisson and Normal Distributions – Test for Goodness of fit – Fitting of a Straight line ($y = a + bx$) , Second degree Parabola ($y = a + bx + cx^2$) by the method of least square.	3
V	Test of Large and Small Sample Tests Chi- square test for in dependence of attributes-test. Analysis of Variance: one way and Two way classification, Design of Experiments - C.R.D, R.B.D & L.S.D.	3

Recommended Textbook(s):

1. S.C. Gupta & V.K. Kapoor, Elements of Mathematical Statistics, 3rd revised edition, Sultan Chand & Sons.

Reference Book(s):

1. Hogg R.V. & Craig A.T. (1998), Introduction to Mathematical Statistics, Macmillan.
2. Mood A.M., Graybill F.A. & Boes D.G. (1974), Introduction to Theory of Statistics, McGraw Hill.
3. O. Kempthorne, Design of Experiments.
4. Das and Giri, Design of Experiments, Wiley Eastern.
5. Vittal, P. R. (2004). Mathematical statistics. Margham Publications.
6. Kapur, J. N & Saxena, H. C. (2010). Mathematical statistics (20th ed.). S. Chand & Company Ltd.

Web Resource(s):

<http://mathworld.wolfram.com>
<https://www.e-booksdirectory.com/details.php?ebook=6650>
<https://ocw.mit.edu/courses/8-223-classical-mechanics-ii-january-iap-2017/pages/lecture-notes/>
<https://www.simplilearn.com/what-is-statistical-analysis-article>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Organize and present statistical data effectively using tables, diagrams, and graphs.	K2, K3
CO2	Compute and interpret measures of central tendency and dispersion for real-world datasets.	K3, K4
CO3	Analyze the relationship between variables using correlation and regression techniques.	K3, K4
CO4	Apply theoretical distributions and evaluate goodness of fit for statistical models.	K3, K4
CO5	Perform hypothesis testing using chi-square tests and interpret results accurately.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	3	2	3	2	2	3	3	2.5
CO2	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO3	3	2	3	3	3	3	2	3	3	3	3	3	2.83
CO4	3	1	3	3	3	3	2	3	3	2	3	3	2.67
CO5	3	1	3	3	3	3	2	3	3	2	3	3	2.67
Mean Overall Score													2.68
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \ \& \ \leq 2$	Medium
$>2 \ \& \ \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective IV	4	4	25	75	100
Course Title		SPECIAL FUNCTIONS					

Learning Objectives

LO1	Develop a comprehensive understanding of Beta and Gamma functions, their properties, transformations, and relationship, along with the fundamental properties of Chebyshev polynomials.
LO2	Develop proficiency in power series, radius of convergence, and the use of power series methods for solving ordinary differential equations.
LO3	Develop an understanding of Hermite differential equations and Hermite polynomials, including their generating functions, Rodrigues formula, orthogonality, and recurrence relations.
LO4	Develop proficiency in solving and analyzing Legendre's equation and Legendre polynomials using generating functions, orthogonality, and recurrence relations.
LO5	Develop an understanding of Bessel's equation and Bessel functions of the first and second kinds, including their series solutions, generating functions, orthogonality, and recurrence relations.

SYLLABUS

Unit	Contents	Hours
I	Beta and Gamma functions, Chebyshev polynomials Euler's Integrals-Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions. Another form of Beta Function, Relation between Beta and Gamma Functions. Chebyshev polynomials, orthogonal properties of Chebyshev polynomials, recurrence relations, generating functions for Chebyshev polynomials.	12
II	Power series and Power series solutions of ordinary differential equations Introduction, summary of useful results, power series, radius of convergence, theorems on Power series Introduction of power series solutions of ordinary differential equation Ordinary and singular points, regular and irregular singular points, power series solution.	12
III	Hermite polynomials Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, generating function for Hermite polynomials. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.	12
IV	Legendre polynomials Definition, Solution of Legendre's equation, Legendre polynomial of degree n, generating function of Legendre polynomials. Definition of $P_n(x)$ and $Q_n(x)$, General solution of Legendre's Equation (derivations not required) to show that $P_n(x)$ is the coefficient of h^n , in the expansion of $(1 - 2xh + h^2)^{-\frac{1}{2}}$ Orthogonal properties of Legendre's polynomials, Recurrence formulas for Legendre's Polynomials.	12
V	Bessel's equation Definition, Solution of Bessel's equation, Bessel's function of the first kind of order n, Bessel's function of the second kind of order n. Integration of Bessel's equation in series form=0, Definition of $J_n(x)$ recurrence formulae for $J_n(x)$ Generating function for $J_n(x)$ orthogonally of Bessel functions.	12

Recommended Textbook(s):

1. Special Functions by J.N.Sharma and Dr.R.K .Gupta, Krishna Prakashan

Reference Book(s):
1. Dr. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Company Pvt. Ltd., Ram Nagar, New Delhi-110055. 2. Shanti Narayan and Dr.P.K. Mittal, Integral Calculus, S. Chand Company Pvt. Ltd., Ram Nagar, New Delhi-110055. 3. George F.Simmons,DifferentialEquationswithApplicationsandHistoricalNotes,Tata Mc GRAW-Hill Edition, 1994.
Web Resource(s):
https://nptel.ac.in

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply the properties and transformations of Beta and Gamma functions and the orthogonal properties, recurrence relations, and generating functions of Chebyshev polynomials to solve related problems.	K1, K2, K3, K4
CO2	Apply power series techniques, convergence concepts, and power series solutions to ordinary differential equations involving ordinary and singular points.	K1, K2, K3, K4
CO3	Analyze Hermite differential equations and construct Hermite polynomials using generating functions and Rodrigues formula, and examine their orthogonal and recurrence properties.	K1, K2, K3, K4, K6
CO4	Analyze Legendre's equation and Legendre polynomials using generating functions, orthogonal properties, and recurrence formulas.	K1, K2, K3, K4
CO5	Apply series solution techniques to Bessel's equation and analyze Bessel functions of the first and second kinds using recurrence, generating, and orthogonality properties.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	1	3	2	3	1	1	3	3	2	1	3	2.17
CO2	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO3	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO4	3	1	3	3	3	1	1	3	3	2	1	3	2.25
CO5	3	1	3	3	3	1	1	3	3	2	1	3	2.25
Mean Overall Score													2.23
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		SEC VI	2	2	25	75	100
Course Title		INTRODUCTION TO AI					

Learning Objectives	
LO1	Develop a foundational understanding of Artificial Intelligence, its goals, applications, intelligent agents, and agent–environment interactions.
LO2	Develop proficiency in understanding and applying problem-solving and search strategies, including uninformed, informed, adversarial, and constraint-based approaches.
LO3	Develop an understanding of knowledge representation and logical reasoning using propositional logic, first-order logic, and inference mechanisms.
LO4	Develop competency in classical and hierarchical planning methods and their application to planning and acting in real-world environments.
LO5	Develop an understanding of expert systems, their architecture, differences from conventional programs, and knowledge representation techniques.

SYLLABUS		
Unit	Contents	Hours
I	Introduction to AI - Foundations AI - Definition, Goals, Applications in real life - Intelligent Agents: Agents and Environments - Good Behavior - Nature of Environments - Structure of Agents (Book 1 - [Sec 1.1 - 1.4, Sec 2.1 - 2.4])	6
II	Problem Solving & Search Problem Solving Agents - Searching for solutions - Uninformed Search Strategies: BFS, DFS - Informed Search Strategies - Heuristic functions - Introduction to Adversarial Search - Constraint Satisfaction Problems (Book 1 - [Sec 3.1 - 3.4], [Sec 4.1 - 4.2], [Sec 5.1 - 5.2], [Sec 6.1 - 6.2])	6
III	Knowledge and Reasoning Basics Logical Agents - Propositional Logic - First Order Logic - Inference: Forward Chaining, Backward Chaining (Book 1 - [Sec 7.1 - 7.5], [Sec 8.1 - 8.3], [Sec 9.1 - 9.3])	6
IV	Planning Fundamental Classical Planning - Planning Algorithms - Hierarchical Planning - Planning and Acting in Real World (Book 1 - [Sec 10.1 - 10.3], [Sec 11.1 - 11.2])	6
V	Expert Systems – Overview Expert Systems - Introduction - Difference between Expert System and Conventional Programs - Architecture of Expert System - Knowledge Representation Technique. (Book 2 - [14.1 - 14.3], [15.1 - 15.4], [16.1 - 16.3])	6

Recommended Textbook(s):
1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education, 4th Edition, 2021. 2. Patterson W D, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, First Edition, 1995.

Reference Book(s):
1. P.Rizwan Ahmed, Artificial Intelligence, Margham Publications, Chennai, 2017 2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, McGraw Hill Education, 3rd Edition, 2017. 3. Andreas C. Müller and Sarah Guido, Machine Learning with Python, O'Reilly Media, 2016. 4. Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT Press, 2016.
Web Resource(s):
1. https://www.geeksforgeeks.org/artificial-intelligence/ 2. https://www.tutorialspoint.com/artificial_intelligence/index.htm 3. https://developers.google.com/machine-learning/crash-course 4. https://scikit-learn.org/stable/ 5. https://www.tensorflow.org/learn

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain the fundamental concepts of Artificial Intelligence, intelligent agents, agent structures, environments, goals, and real-world applications.	K1, K2
CO2	Apply uninformed and informed search strategies, heuristic functions, adversarial search, and constraint satisfaction techniques to solve AI problems.	K1, K2, K3, K4
CO3	Apply propositional and first-order logic and inference techniques, including forward and backward chaining, to represent knowledge and perform reasoning.	K1, K2, K3, K4
CO4	Analyze classical and hierarchical planning approaches and their application to planning and acting in real-world environments.	K1, K2, K3, K4
CO5	Analyze the architecture, characteristics, and knowledge representation techniques of expert systems and distinguish them from conventional programs.	K1, K2, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	2	3	2	2	3	3	2	2	2	3	3	2.5
CO2	3	2	3	3	3	3	3	2	3	3	3	3	2.83
CO3	3	2	3	3	3	3	3	3	3	3	3	3	2.92
CO4	3	2	3	3	3	3	3	2	3	3	3	3	2.83
CO5	3	2	3	3	3	3	3	2	3	3	3	3	2.83
Mean Overall Score													2.78
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		SEC VII	2	2	25	75	100
Course Title		R PROGRAMMING (PRACTICAL)					

Learning Objectives

LO1	Develop foundational programming skills in R for performing arithmetic, matrix operations, data manipulation, and simple function development.
LO2	Develop proficiency in creating and interpreting graphical representations of data using R.
LO3	Develop competency in calculating and interpreting descriptive statistical measures for summarizing data.
LO4	Develop the ability to analyze relationships between variables using correlation, regression, and statistical testing techniques.
LO5	Develop proficiency in applying advanced statistical tests and Analysis of Variance techniques to analyze data using R.

SYLLABUS

Unit	Contents	Hours
I	R Programming Fundamentals and Data Operations Introduction to R programming environment and basic syntax - Arithmetic and matrix operations - Creation and manipulation of vectors, matrices and data objects - Development and use of simple functions	6
II	Data Visualization and Graphics in R Plotting bar charts and scatter plots - Plotting histograms and pie charts - Graphics for grouped data - Graphical display of statistical distributions	6
III	Descriptive Statistics and Data Analysis Measures of central tendency – mean, median and mode - Measures of dispersion – standard deviation and mean deviation - Statistical summaries and interpretation of descriptive measures	6
IV	Correlation, Regression and Statistical Testing Correlation analysis and interpretation - Regression analysis using linear models - Large sample tests - Small sample tests – t-tests	6
V	Advanced Statistical Tests and ANOVA Small sample F-tests - Chi-square tests - One-way ANOVA - Two-way ANOVA	6

Reference Book(s):

1. Alain F. Zuur, Elena N. Ieno, Erik H.W.G. Meesters Beginner's Guide to R - Springer, 2009.
2. Allerhand M. Tiny Handbook of R - SpringerBriefs in Statistics, 2011
3. Baayen R. Analyzing Linguistic Data - A Practical Introduction to Statistics using R , 2008.
4. Gardener M. Beginning R - The Statistical Programming Language , 2012.
5. Jim Albert, Maria Rizzo R by Example, 2012.
6. Matloff N. Art of R Programming - A Tour of Statistical Software Design , 2011.

Web Resource(s):

1. <https://www.classcentral.com/course/edx-statistics-and-r-2960>
2. <https://www.classcentral.com/course/probability-intro-6099>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply R programming constructs to perform arithmetic and matrix operations, manipulate vectors, matrices and data objects, and develop simple functions.	K1, K2, K3, K6
CO2	Create and interpret bar charts, scatter plots, histograms, pie charts, grouped-data graphics, and graphical displays of statistical distributions using R.	K2, K3, K6
CO3	Calculate and interpret measures of central tendency, dispersion, and statistical summaries using R.	K1, K2, K3
CO4	Analyze correlation and linear regression and apply large- and small-sample statistical tests, including t-tests.	K2, K3, K4
CO5	Apply F-tests, chi-square tests, one-way ANOVA, and two-way ANOVA for statistical data analysis.	K1, K2, K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO2	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO3	3	2	3	3	3	3	2	3	3	2	3	3	2.75
CO4	3	2	3	3	3	3	2	3	3	3	3	3	2.83
CO5	3	2	3	3	3	3	2	3	3	3	3	3	2.83
Mean Overall Score													2.78
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

For Other Departments

B.Com (CA)

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		CORE VI	5	5	25	75	100
Course Title		BUSINESS STATISTICS (Theory – 20% and Problems 80%)					

Learning Objectives

LO1	Develop a foundational understanding of statistics, including the collection, classification, tabulation, and presentation of statistical data.
LO2	Develop proficiency in calculating and interpreting various measures of central tendency and positional measures.
LO3	Develop competency in measuring and interpreting dispersion, moments, skewness, and kurtosis of statistical data.
LO4	Develop the ability to analyze relationships between variables using correlation and regression techniques.
LO5	Develop an understanding of index numbers, their construction methods, applications, and consistency tests.

SYLLABUS

Unit	Contents	Hours
I	Introduction: Meaning and Definition of Statistics- Collection and Tabulation of Statistical Data- Presentation of Statistical Data-Graphs and Diagrams.	15
II	Measures of Central Tendency: Arithmetic mean - median - mode - geometric mean and Harmonic mean and their properties - Quartiles and Deciles.	15
III	Measures of Dispersion: Range, Quartile deviation - mean deviation - Standard deviation – Moments - Skewness and Kurtosis	15
IV	Correlation and Regression : Simple Correlation-Scatter Diagram- Karl Pearson's Correlation, Spearman's Rank Correlation- Regression : Regression Coefficients- properties- Linear Regression equations.	15
V	Index Numbers: Meaning – Definition - characteristics uses - Types of Index Numbers - Problems in Construction of Index Numbers - Methods, Simple Aggregate, Weighted Aggregate, Test of Consistency of Index numbers – Time Reversal Test, Factor Reversal Test.	15

Recommended Textbook(s):

1. R.S.N. Pillai&Bhagavathi, Statistics-Sultand Chand and Sons
2. P.R. Vittal- Mathematical Statistics -Margham Publications Chennai.
3. Fundamental of Mathematical Statistics-S.C.Gupta and V.K.Kapoor-Sultand Chand and Sons.
4. S.P. Rajagopalan& R. Sattanathan, Business Statistics & Operation Research 3rd Edition, Vijay Nicole Publications, Chennai.

Reference Book(s):

1. S.P. Gupta- Statistical methods-sultan chand Delhi.
2. P.R. Vittal-Business Mathematics and Statistics-Margham Publications Chennai.
3. Element of statistics-Mode.E.B.-Prentice Hall

4. J.K. Sharma, Business Statistics - Pearson Education
5. R.S. Bhardwaj, Business Mathematics & Statistics, Excel Books Publisher, New Delhi
Web Resource(s):
1. https://www.britannica.com/biography/Henry-Briggs
2. https://corporatefinanceinstitute.com/resources/data-science/central-tendency/
3. https://www.crestcapital.com/tax/business_statistics
4. https://www.youtube.com/watch?v=8gWQ7ehyGos
5. https://missionsustainability.org/blog/business-statistics-
6. https://www.scribd.com/document/701836534/Business-Statistics

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply appropriate methods for collecting, tabulating, and presenting statistical data using graphs and diagrams.	K1, K2, K3
CO2	Calculate arithmetic mean, median, mode, geometric mean, harmonic mean, quartiles, and deciles and interpret their properties.	K1, K2, K3
CO3	Calculate measures of dispersion, moments, skewness, and kurtosis and analyze the characteristics of statistical data.	K1, K2, K3, K4
CO4	Analyze relationships between variables using scatter diagrams, Karl Pearson’s correlation, Spearman’s rank correlation, regression coefficients, and linear regression equations.	K1, K2, K3, K4
CO5	Apply appropriate methods to construct and analyze index numbers, including simple and weighted aggregate methods, and assess their consistency using time reversal and factor reversal tests.	K1, K2, K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	1	2	2	2	2	2	2	2.08
CO2	3	3	2	2	2	1	2	2	2	2	1	3	2.08
CO3	3	2	2	2	1	2	2	2	2	2	2	2	2
CO4	3	2	2	2	1	3	2	2	2	2	3	2	2.17
CO5	3	2	2	2	2	2	2	2	2	2	2	2	2.08
Mean Overall Score													2.08
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

B.B.A

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		ELECTIVE III	3	3	25	75	100
Course Title		BUSINESS STATISTICS - I (Theory – 20% and Problems 80%)					

Learning Objectives

LO1	Knowledge about collection of Data in Graphs and diagram
LO2	Apply the Measures of Central Tendency in business
LO3	Understanding the Measures of Dispersion
LO4	Understand the measures of Skewness
LO5	Understanding about Correlation

SYLLABUS

Unit	Contents	Hours
I	Introduction to Statistics: Meaning and Definition of Statistics - Collection and Tabulation of Statistical Data - Presentation of Statistical Data - Graphs and Diagrams.	9
II	Measures of Central Tendency: Arithmetic Mean - Median and Mode - Harmonic Mean and Geometric Mean.	9
III	Measures of Dispersion: Range, Quartile deviation - Mean Deviation - Standard Deviation - Coefficient of Variation.	9
IV	Correlation: Karl Pearson's Coefficient of Correlation - Spearman's – Bowley's Coefficient of correlation - Rank Correlation	9
V	Regression: Regression lines – Regression Coefficients – Properties – Difference between correlation and regression.	9

Recommended Textbook(s):

1. R.S.N. Pillai&Bhagavathi, Statistics-Sultand Chand and Sons
2. P.R. Vittal- Mathematical Statistics -Margham Publications Chennai.
3. Fundamental of Mathematical Statistics-S.C.Gupta and V.K.Kapoor-Sultand Chand and Sons.
4. S.P. Rajagopalan& R. Sattanathan, Business Statistics & Operation Research 3rd Edition, Vijay Nicole Publications, Chennai.

Reference Book(s):

1. S.P. Gupta- Statistical methods-sultan chand Delhi.
2. P.R. Vittal-Business Mathematics and Statistics-Margham Publications Chennai.
3. Element of statistics-Mode.E.B.-Prentice Hall
4. J.K. Sharma, Business Statistics - Pearson Education
5. R.S. Bhardwaj, Business Mathematics & Statistics, Excel Books Publisher, New Delhi

Web Resource(s):

1. <https://www.britannica.com/biography/Henry-Briggs>
2. <https://corporatefinanceinstitute.com/resources/data-science/central-tendency/>
3. https://www.crestcapital.com/tax/business_statistics
4. <https://www.youtube.com/watch?v=8gWQ7ehyGos>
5. <https://missionsustainability.org/blog/business-statistics->
6. <https://www.scribd.com/document/701836534/Business-Statistics>

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Learn the basics of statistical method	K2
CO2	Calculate and apply Measures of Central Tendency	K3
CO3	Compute and compare Measures of dispersion	K4
CO4	Analyze and interpret of skewness	K4
CO5	Evaluate Statistical Quality Control chart	K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	2	2	1	2	3	1	2	1	1	1.83
CO2	3	3	2	3	3	1	2	3	2	3	2	2	2.42
CO3	2	3	2	3	2	2	3	2	2	2	3	2	2.33
CO4	2	3	2	3	2	2	2	2	2	2	2	2	2.17
CO5	2	3	1	3	2	2	3	2	1	2	3	2	2.17
Mean Overall Score													2.18
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

B.B.A

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		ELECTIVE III	3	3	25	75	100
Course Title		OPERATION RESEARCH - I (Theory – 20% and Problems 80%)					

Learning Objectives

LO1	Understand Linear Programming Problem.
LO2	Analyze the simplex method.
LO3	Understanding the Decision theory.
LO4	Understand the basic Queuing theory.
LO5	Understanding about Assignment Problem.

SYLLABUS

Unit	Contents	Hours
I	Introduction to Linear Programming problem: Graphical method of the solution of LPP	9
II	Linear Programming problem: Canonical and Standard form-Simplex Method of LPP.	9
III	Transportation Problems : Balanced and unbalanced problems – Initial basic feasible solutions by North west corner rule – Least Cost Method - Vogels Approximation method.	9
IV	Assignment problem: Hungarian method - Minimization and Maximization case - unbalanced assignment problem.	9
V	Decision Theory: Decision making under conditions of uncertainty-Minimax criterion-Maximini criterion and Minimax regret criterion.	9

Recommended Textbook(s):

1. Kapoor V.K-Operation Research- Sult and Chand and Sons.
2. P.R. Vittal- Operation Research- Margham Publications Chennai.

Reference Book(s):

1. S.P. Gupta- Operation Research -sultan chand and Sons.
2. P.R. Vittal-Business-Operation Research-Margham Publications Chennai.

Web Resource(s):

1. <https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf>
2. https://ycmou.ac.in/media/post_image/Operations_Research.pdf
3. <https://nptel.ac.in/courses/111107128>
4. https://www.youtube.com/playlist?list=PLwdnzlV3ogoX_AO-g9wEvUNu5cb_K-r45

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain and formulate Linear Programming Problems (LPP)	K3
CO2	Apply and solve Linear Programming Problems using the Simplex Method	K3
CO3	Analyze and use Decision Theory	K4
CO4	Analyze Queuing model	K4
CO5	Evaluate Replacement model	K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	3	1	2	1	1	2	3	1	2	1	1	1.75
CO2	2	3	2	3	2	2	1	2	2	3	2	2	2.17
CO3	1	2	3	3	3	3	3	1	3	1	3	3	2.42
CO4	3	1	2	1	2	2	2	3	2	2	2	2	2
CO5	2	2	1	2	1	1	1	2	1	3	1	1	1.5
Mean Overall Score													1.97
Correlation													Medium

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

B.B.A

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		ELECTIVE IV	4	3	25	75	100
Course Title		BUSINESS STATISTICS - II (Theory – 20% and Problems 80%)					

Learning Objectives

LO1	Understanding the Probability.
LO2	Understanding Regression equations.
LO3	Understand index number.
LO4	Understand about concept of Time series
LO5	Statistical Quality Control

SYLLABUS

Unit	Contents	Hours
I	Skewness and Kurtosis: Karl Pearson's - Bowley's and Kelly's co-efficient of skewness – Moments - Kurtosis.	12
II	Time Series: Definition and Uses – Components – Semi Average, Moving Average – Method of Least Square – Seasonal Variation – Simple Average Method.	12
III	Index Number: Definition – Uses – Unweighted Index Number – Simple Aggregate Price Index, Simple Average of Price Relatives Index – Weighted Index – Laspeyre's, Paasche, Drobish Bowley's – Marshall Edge worth, Fisher Ideal Index – Time and Factor Reversal Test – Cost of Living Index.	12
IV	Probability: Addition Theorem, Multiplication Theorem - Baye's Theorem based on problems	12
V	Statistical Quality Control: Control Charts – $\bar{X}$ and R , P, NP , C – Charts.	12

Recommended Textbook(s):

1. R.S.N. Pillai & Bhagavathi, Statistics-Sultand Chand and Sons
2. P.R. Vittal- Mathematical Statistics -Margham Publications Chennai.
3. Fundamental of Mathematical Statistics-S.C.Gupta and V.K.Kapoor-Sultand Chand and Sons.
4. S.P. Rajagopalan& R. Sattanathan, Business Statistics & Operation Research 3rd Edition, Vijay Nicole Publications, Chennai.

Reference Book(s):

1. S.P. Gupta- Statistical methods-sultan chand Delhi.
2. P.R. Vittal-Business Mathematics and Statistics-Margham Publications Chennai.
3. Element of statistics-Mode.E.B.-Prentice Hall
4. J.K. Sharma, Business Statistics - Pearson Education

Web Resource(s):

1. <https://www.simplilearn.com/what-is-statistical-analysis-article>

2. <https://www.youtube.com/watch?v=1Q7x7UmlORs&list=PLNKD1qB9pptsPVHBQenKnI-Xn8JoeJRPx>
3. <https://www.youtube.com/watch?v=9wCnvr7Xw4E&list=PLblh5JKOoLUK0FLuzwntyYI10UQFUhsY9&index=20>
4. <https://www.youtube.com/watch?v=OQV8WmUdeIo&list=PLbMVogVj5nJSpj5sl-8tdKARg1lw2wEa->

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply Probability possibilities	K3
CO2	Compute and interpret Regression	K4
CO3	Calculate and compute price index of current year and base year	K5
CO4	Analyze Time series moving average and method of least square.	K4
CO5	Apply Statistical Quality Control	K3

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	1	2	2	1	2	3	1	2	1	1	1.83
CO2	2	3	2	3	3	2	1	2	2	3	2	2	2.25
CO3	1	2	3	3	2	2	2	1	3	1	3	3	2.17
CO4	3	2	2	3	2	2	3	3	2	2	2	2	2.33
CO5	2	3	1	2	1	1	2	2	1	3	1	1	1.67
Mean Overall Score													2.05
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

B.B.A

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		ELECTIVE IV	4	3	25	75	100
Course Title		OPERATION RESEARCH - II (Theory – 20% and Problems 80%)					

Learning Objectives

LO1	Understanding Sequence Problems.
LO2	Formulation of Transportation problem and finding an initial basic feasible solution.
LO3	Expressing Replacement model, money value change and without change.
LO4	Analyse Network models and constructing network- critical path, various floats.
LO5	Analyse Game Theory and Decision Theory

SYLLABUS

Unit	Contents	Hours
I	Game Theory: Maximin-Minmax criterion, Saddle point, Dominance property, Graphical method for solving 2xn and mx2 game.	12
II	Sequencing Problem: Processing n jobs on 2 machines-Processing n jobs on 3 machines-processing n-jobs on m-machines and processing 2-jobs on m-machines.	12
III	Replacement: Gradual Failure – Retrogressive failure – replacement of an item maintenance cost increases with time and money value is not changed.	12
IV	Network models: PERT and CPM - difference between PERT and CPM constructing network - critical path - various floats - three-time estimates for PERT.	12
V	Inventory models: Holding cost - Ordering Cost – Economic Order Quantity – Re-order level - Time interval between two consecutive orders- number of orders - with and without shortages.	12

Recommended Textbook(s):

1. Kapoor V.K-Operation Research- Sultan and Chand and Sons.
2. P.R. Vittal- Operation Research- Margham Publications Chennai.

Reference Book(s):

1. S.P. Gupta- Operation Research -sultan chand and Sons.
2. P.R. Vittal-Business-Operation Research-Margham Publications Chennai.

Web Resource(s):

1. <https://www.youtube.com/watch?v=rrfFTdO2Z7I&list=PLabr9RWfBcnp8NM55-ta-sT-G6fg8A8Z>
2. <https://www.youtube.com/watch?v=vKVkOpNDZ2s>
3. https://www.amirajcollege.in/wp-content/uploads/2020/10/3151910-operations-research-theory-and-applications-by-j.-k.-sharma-z-lib.org_.pdf
4. https://mrcet.com/downloads/digital_notes/ME/IV%20year/Operations%20Research.pdf

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Analyse and solve sequencing problems	K4
CO2	Apply Transportation Problem	K3
CO3	Apply Assignment Problem	K3
CO4	Analyse and construct Network models	K4
CO5	Evaluate Game Theory and Decision Theory	K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO3	PSO3	PSO4	PSO5	
CO1	3	3	2	3	2	1	2	3	1	2	2	1	2.08
CO2	2	3	2	3	3	1	1	2	2	3	2	2	2.17
CO3	2	3	1	2	3	1	2	2	1	3	2	2	2
CO4	3	2	2	3	2	2	3	3	2	2	3	2	2.42
CO5	3	3	2	3	2	2	3	3	2	2	3	2	2.5
Mean Overall Score													2.23
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

B.Sc (CS)

Semest er	Course Code	Course Category	Hours / Week	Cred its	Marks for Evaluation		
					CIA	ESE	Total
III		Elective - III	5	4	25	75	100
Course Title		Statistical Methods and their Applications – I					

Learning Objectives	
LO1	Understand scope of statistics and methods of data classification, tabulation, and graphical presentation.
LO2	Compute and interpret measures of central tendency and positional measures.
LO3	Calculate and compare measures of dispersion.
LO4	Measure and interpret skewness and kurtosis of distributions.
LO5	Analyze correlation and regression between variables.

SYLLABUS		
Unit	Contents	Hours
I	Introduction - scope and limitations of statistical methods - classification of data -Tabulation of data- Diagrammatic and Graphical representation of data – Frequency curve, cumulative frequency curve (Ogive), Lorenz curve.	15
II	Measures of Central Tendency: Arithmetic mean, median, mode, geometric mean and Harmonic mean and their properties, Quartiles and Deciles.	15
III	Measures of Dispersion: Range, Quartile deviation, mean deviation, Standard deviation, combined Standard deviation, and their relative measures	15
IV	Measures of Skewness: Karl Pearson's, Bowley's, and kelly's coefficient of Skewness, kurtosis based on moments.	15
V	Correlation: Karl Pearson - Spearman's Rank correlation - concurrent deviation methods. Regression Analysis: Simple Regression Equations.	15

Text Book(s):
1. Fundamental of Mathematical Statistics-S.C.Gupta&V.K.Kapoor-Sultan Chand
Reference Book(s):
1. Mathematical Statistics – Dr. P.R. Vittal – Margham Publications 2. Statistical Methods-Snedecor G.W.& Cochran W.G.oxford&+DII 3. Elements of Statistics -Mode. E.B.-Prentice Hall 4. Statistical Methods-Dr.S.P.Gupta-Sultan Chand & Sons
Web Resource(s):
1. https://www.simplilearn.com/what-is-statistical-analysis-article

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain and present data using statistical methods.	K1, K2, K3
CO2	Apply measures of central tendency in data analysis.	K2, K3

CO3	Evaluate variability using dispersion measures.	K3, K4
CO4	Interpret distribution shape using skewness and kurtosis.	K2, K4
CO5	Determine relationships using correlation and regression techniques.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	3	2	3	1	2	2	1	1	1	2.0
CO2	3	1	3	3	3	2	1	2	2	1	1	1	1.9
CO3	3	1	3	3	3	2	1	2	2	2	1	1	2.0
CO4	3	1	3	3	2	2	1	2	3	2	1	1	2.0
CO5	3	2	3	3	3	3	2	2	3	3	2	2	2.6
	Mean Overall Score												2.1
	Correlation												High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III		Elective – III	5	4	25	75	100
Course Title		Resource Management Techniques-I					

Learning Objectives	
LO1	Understand the formulation and solution of Linear Programming Problems using graphical and simplex methods.
LO2	Learn advanced methods of LPP including duality, dual simplex, and two-phase methods.
LO3	Understand the formulation and solution of Transportation Problems using different methods.
LO4	Learn to solve Assignment Problems and Traveling Salesman Problems.
LO5	Understand and solve sequencing problems for optimal scheduling.

SYLLABUS		
Unit	Contents	Hours
I	Linear Programming Problem: Formulation - Graphical Solution-General LPP-Canonical and Standard form - Simplex Algorithm.	15
II	Linear Programming Problem (Cont.): Properties of duality Fundamental theorem of duality Complementary slackness theorem (statement only) - Dual Simplex Method - Two phase Method- Artificial variables Technique.	15
III	Transportation Problem: Formulation - Initial basic feasible solution – NorthWest Corner Rule-Least Cost method - Vogel's Approximation Method - Degeneracy in T.P, Unbalanced T.P, Optimal Solution of T.P - MODI Method.	15
IV	Assignment Problem: Formulation-Hungarian assignment method-Traveling Salesman Problem.	15
V	Sequencing Problem: n jobs through 1 machines-n jobs through 2 machines -n jobs through 3 machines-two jobs through mmachines-n jobs through m machines.	15

Text Book(s):
1. Problems in Operations Research (2000), S. Chand, New Delhi by P.K. Gupta and D.S. Hira
Reference Book(s):
1. Operation Research: An introduction by HamelyA Taha, Ninth Edition, Prentice Hall, New Delhi, 2011. 2. Resource Management Techniques, by V. Sundaresan, K.S. Subramaniya, K. Ganesan, New Revised Edition, AR Publications, Sirkalli, 2002
Web Resource(s):
1. https://www.theopeneducator.com/operations

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Formulate and solve Linear Programming Problems using graphical and simplex methods.	K2, K3
CO2	Apply duality concepts and advanced simplex techniques to solve LPP.	K3, K4
CO3	Solve Transportation Problems and obtain optimal solutions.	K3, K4
CO4	Apply Hungarian method to solve Assignment and Traveling Salesman Problems.	K3, K4
CO5	Solve sequencing problems for optimal job scheduling.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PS O1	PS O2	PS O3	PS O4	PS O5	
CO1	3	1	3	3	3	2	1	2	3	2	1	1	2.1
CO2	3	1	3	3	3	2	1	2	3	2	2	1	2.2
CO3	3	1	3	3	3	2	1	2	2	3	2	1	2.2
CO4	3	2	3	3	3	2	1	2	2	3	2	1	2.3
CO5	3	1	3	3	3	2	1	2	2	3	3	2	2.3
Mean Overall Score													2.22
Correlation													High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$> 1 \text{ \& } \leq 2$	Medium
$> 2 \text{ \& } \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective – IV	6	3	25	75	100
Course Title		Statistical Methods and their Applications- II					

Learning Objectives	
LO1	Understand the basic concepts of probability and apply probability theorems to solve simple problems.
LO2	Learn the concepts of random variables and mathematical expectation and compute mean and variance.
LO3	Understand standard probability distributions and apply them to real-life situations.
LO4	Learn the procedure of hypothesis testing and apply appropriate statistical tests.
LO5	Understand analysis of variance and the basic principles of design of experiments.

SYLLABUS		
Unit	Contents	Hours
I	Probability: Introduction - Sample Space- Events- Classical Definition of Probability-Addition and Multiplication Theorem- Conditional Probability - Baye's Theorem – Simple Problems	18
II	Random Variables: Definition, Discrete Random Variable, Continuous Random Variable, Cumulative Distribution, Properties of Distribution function, Function of Random Variable. Mathematical Expectation: Definitions, Properties and Theorems on Expectation, Variance – Formula for Variance of X – Theorems – Techebechey's Inequality – Simple Problems.	18
III	Standard distributions - Binomial, Poisson, Normal distribution and fitting of these distribution.	18
IV	Test of Hypothesis: Sample and population hypothesis-large and small samples-Procedure for testing of hypothesis-standard Error-critical values-large sample tests for mean and proportions - Small sample proportions tests-paired t-test for Mean, Difference between Means and F-test– Simple Problems.	18
V	Analysis of variance – One and Two way classifications-Basic principle of design of Experiments Randomization, Replication and Local Control – C.R.D., R.B.D. and L.S.D.	18

Recommended Text Books:
1. Fundamental of Mathematical Statistics-S.C.Gupta&V.K.Kapoor-Sultan Chand 2. Statistical methods- Snedecor G.W & Cochran W.G. oxford & DII
Reference Books:
1. Mathematical Statistics – Dr. P.R. Vittal – Margham Publications 2. Statistical Methods-Snedecor G.W.& Cochran W.G.oxford&+DII 3. Elements of Statistics -Mode. E.B.-Prentice Hall 4. Statistical Methods-Dr.S.P.Gupta-Sultan Chand & Sons
Web Resources:
1. https://www.simplilearn.com/what-is-statistical-analysis-article

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply probability concepts and theorems to solve problems.	K2, K3
CO2	Compute expectation and variance of random variables and apply their properties.	K2, K3
CO3	Analyze and fit standard probability distributions.	K3, K4
CO4	Perform hypothesis testing using appropriate statistical tests.	K3, K4, K5
CO5	Apply ANOVA and principles of experimental design in problem solving.	K3, K4

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes(PSOs)					Mean Score of COs
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO2	PSO3	PSO4	PSO5	
CO1	3	1	3	3	2	2	1	2	2	1	1	1	1.8
CO2	3	2	3	3	3	2	1	2	3	2	1	1	2.2
CO3	3	2	3	3	3	3	1	3	3	2	2	1	2.4
CO4	3	2	3	3	3	3	1	3	3	3	2	1	2.5
CO5	3	2	3	3	3	3	2	3	3	3	3	2	2.8
	Mean Overall Score												2.34
	Correlation												

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective – IV	6	3	25	75	100
Course Title		Resource Management Techniques-II					

Learning Objectives	
LO1	Understand decision-making methods under uncertainty and risk using different decision criteria.
LO2	Learn the concepts of game theory and solve two-person zero-sum games using various methods.
LO3	Understand the structure of queuing systems and analyze basic Poisson queue models.
LO4	Learn the principles and formulation of dynamic programming problems.
LO5	Understand project planning and scheduling using CPM and PERT techniques.

SYLLABUS		
Unit	Contents	Hours
I	Decision Theory: Decision making under conditions of uncertainty -minimax criterion - maximin criterion - minimax regret criterion- Hurwicz criterion - Laplace criterion. Decision making under conditions of risk- EMV-EOL simple Problems.	18

II	Game Theory: Characteristics-game models - Two-person zero-sum game with saddle point, without saddle point (Algebraic, arithmetic and matrix methods) - Minimax and Maximin Principles - Dominance Solving 2 x n or m x 2 game by graphical method.	18
III	Queuing Theory: Basic Concepts-Characteristics of Queueing Systems Poisson process and Exponential Distribution - Transient and Steady states-Poisson Queues: (M/M/1); (00/FCFS)-(M/M/1); (N/FCFS).	18
IV	Dynamic Programming: Introduction-distinguishing characteristics-approach formation of DPP-Problems	18
V	Network Analysis: Project-Planning-Scheduling-Controlling Basic Concepts Construction of network-Critical Path Method(CPM)-Programme Evaluation Review Technique (PERT).	18

Recommended Text Books:
1. Problems in Operations Research (2000), S. Chand, New Delhi by P.K. Gupta and D.S. Hira
Reference Books:
1. Operation Research: An introduction by HamelyA Taha, Ninth Edition, Prentice Hall, New Delhi, 2011. 2. Resource Management Techniques, by V. Sundaresan, K.S. Subramaniya, K. Ganesan, New Revised Edition, AR Publications, Sirkalli, 2002
Web Resources:
1. https://www.theopeneducator.com/operations

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Apply decision criteria to solve problems under uncertainty and risk.	K2, K3
CO2	Analyze and solve two-person zero-sum games using appropriate methods.	K3, K4
CO3	Evaluate performance measures of basic queuing models.	K3, K4
CO4	Formulate and solve problems using dynamic programming techniques.	K3, K4
CO5	Apply CPM and PERT techniques for project planning and control.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes(PSOs)					Mean Score of COs
	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO7	PS O1	PS O2	PSO3	PSO4	PSO 5	
CO1	3	1	3	3	3	2	1	2	2	2	1	1	2.0
CO2	3	2	3	3	3	2	1	2	3	2	2	1	2.3
CO3	3	1	3	3	3	3	1	2	3	3	2	1	2.3
CO4	3	2	3	3	3	3	1	3	3	3	2	1	2.5
CO5	3	2	3	3	3	3	2	3	3	3	3	2	2.8
	Mean Overall Score												2.38
	Correlation												

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective –V	2	2	25	75	100
Course Title		Practical - Statistical Methods and their Applications-I & II					

Learning Objectives	
LO1	Understand the methods of collection, classification, and presentation of statistical data using tables, diagrams, and graphs.
LO2	Apply techniques to compute and interpret measures of central tendency and dispersion, including coefficient of variation.
LO3	Analyze relationships between variables using correlation and regression methods.
LO4	Apply theoretical probability distributions and use the method of least squares for curve fitting.
LO5	Perform statistical hypothesis testing using chi-square tests and analyze variance using ANOVA and experimental design methods.

SYLLABUS		
Unit	Contents	Hours
I	Collection and Presentation of Statistical Data Construction of Uni-variate frequency distribution – Diagrammatic and Graphical Representation of Statistical Data.	6
II	Measures of Central Tendency and Dispersion Computation of Measures of Central Tendency – Computation of Measures of Dispersion (absolute and relative measures) – Coefficient of Variation.	6
III	Correlation and Regression Computation of Karl Pearson's Coefficient of Correlation and Spearman's Rank Correlation Coefficient–Regression equation (two variables only).	6
IV	Theoretical Distributions and Methods of Least Squares Fitting of Binomial, Poisson and Normal Distributions – Test for Goodness of fit – Fitting of a Straight line ($y=a+bx$), Second degree Parabola ($y=a+bx+cx^2$) by the method of least square.	6
V	Test of Large and Small Sample Tests Chi- square test for independence of attributes-test. Analysis of Variance: one way and Two way classification, Design of Experiments-C.R.D,R.B.D & L.S.D.	6

Recommended Text Books:
1. Fundamental of Mathematical Statistics-S.C.Gupta&V.K.Kapoor-Sultan Chand 2. Mathematical Statistics – Dr. P.R. Vittal – Margham Publications
Reference Books:
1. Statistical Methods-Snedecor G.W.& Cochran W.G.oxford&+DII 2. Elements of Statistics -Mode. E.B.-Prentice Hall 3. Statistical Methods-Dr.S.P.Gupta-Sultan Chand & Sons
Web Resources:
1. https://www.simplilearn.com/what-is-statistical-analysis-article

Course Outcomes
Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Organize and present statistical data effectively using tables, diagrams, and graphs.	K2, K3
CO2	Compute and interpret measures of central tendency and dispersion for real-world datasets.	K3, K4
CO3	Analyze the relationship between variables using correlation and regression techniques.	K3, K4
CO4	Apply theoretical distributions and evaluate goodness of fit for statistical models.	K3, K4
CO5	Perform hypothesis testing using chi-square tests and interpret results accurately.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO2	PSO3	PSO4	PSO 5	
CO1	3	3	3	2	1	2	2	2	2	2	2	1	2.08
CO2	3	3	3	3	3	2	1	3	3	2	1	1	2.3
CO3	3	2	2	3	3	3	1	2	3	3	2	1	2.33
CO4	3	2	3	2	3	3	1	3	3	3	2	1	2.41
CO5	3	2	2	3	2	2	2	3	3	3	3	2	2.5
	Mean Overall Score												2.32
	Correlation												High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
≤ 1	Low
$>1 \text{ \& } \leq 2$	Medium
$>2 \text{ \& } \leq 3$	High

Note:

Question Paper Setting:

5 questions are to be set without omitting any unit. All questions carry equal marks. Any 3 questions are answered in 3 hours duration.

Examinations Distribution of Marks

University Examinations (Written Practical) 75

Marks CIA (Including Practical Record and VIVA) 25

Marks

Total 100Marks

Semester	Course Code	Course Category	Hours / Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV		Elective –V	2	2	25	75	100
Course Title		Practical – Resource Management Techniques-I & II					

Learning Objectives	
LO1	Understand and formulate real-world optimization problems using linear programming models.
LO2	Apply mathematical techniques to solve transportation, assignment, and sequencing problems.
LO3	Analyze decision-making situations under uncertainty and risk using quantitative methods.
LO4	Evaluate system performance using queuing models and dynamic programming techniques.
LO5	Apply network models such as CPM and PERT for project planning and scheduling.

SYLLABUS		
Unit	Contents	Hours
I	Linear Programming Problems (LPP) Formulation of LPP – Graphical Solution – General LPP – Canonical and Standard Forms – Simplex Method – Artificial Variables Technique – Two-Phase Method – Duality: Properties and Fundamental Theorem (statement only) – Dual Simplex Method – Complementary Slackness (statement only).	6
II	Transportation and Assignment Models Transportation Problem: Formulation – Initial Basic Feasible Solutions (North-West Corner Rule, Least Cost Method, Vogel's Approximation Method) – Degeneracy and Unbalanced T.P – Optimal Solution using MODI Method. Assignment Problem: Formulation – Hungarian Method – Traveling Salesman Problem (basic concept).	6
III	Decision Theory and Game Theory Decision Making under Uncertainty: Maximin, Minimax, Minimax Regret, Hurwicz, Laplace Criteria. Decision Making under Risk: EMV and EOL (simple problems). Game Theory: Characteristics – Two-person Zero-Sum Games – Saddle Point and Non-Saddle Point Problems – Algebraic, Arithmetic, and Matrix Methods – Dominance Principle – Graphical Method (2×n or m×2 games).	6
IV	Queuing and Dynamic Programming Queuing Theory: Basic Concepts – Queue Characteristics – Poisson Process – Exponential Distribution – Models: (M/M/1):(∞/FCFS), (M/M/1):(N/FCFS). Dynamic Programming: Introduction – Characteristics – Formulation and Solution of DPP Problems.	6
V	Sequencing and Network Analysis Sequencing Models: n Jobs through 1, 2, and 3 Machines – Two Jobs through m Machines – n Jobs through m Machines. Network Analysis: Project Planning – Scheduling and Controlling – Network Construction – Critical Path Method (CPM) – Programme Evaluation and Review Technique (PERT).	6

Recommended Text Books:	
1. Operations Research – Kanti Swarup, P.K. Gupta, Man Mohan, Sultan Chand & Sons, Latest Edition. 2. Operations Research – Hamdy A. Taha, Pearson Education, 10th Edition.	
Reference Books:	
1. Introduction to Operations Research – Frederick S. Hillier, Gerald J. Lieberman, cGraw-Hill Education, 10th Edition. 2. Operations Research Theory and Applications – J.K. Sharma, Macmillan Publishers India, Latest Edition.	
Web Resources:	
https://nptel.ac.in/courses/110106062 https://ocw.mit.edu/courses/15-053-optimization-methods-in-management-science-spring-2013/ https://www.geeksforgeeks.org/operations-research/ https://www.tutorialspoint.com/operations_research/index.htm https://en.wikipedia.org/wiki/Operations_research	

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Formulate and solve linear programming problems using graphical and simplex methods.	K2, K3
CO2	Apply optimization techniques to transportation, assignment, and sequencing problems.	K3, K4
CO3	Analyze decision-making scenarios using decision theory and game theory models.	K3, K4
CO4	Evaluate real-life systems using queuing theory and dynamic programming approaches.	K3, K4
CO5	Apply network analysis techniques (CPM and PERT) for project scheduling and management.	K3, K4, K5

Relationship Matrix:

Course Outcomes (COs)	Program Outcomes (POs)							Program Specific Outcomes (PSOs)					Mean Score of COs
	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO7	PS O1	PS O2	PSO3	PSO4	PSO 5	
CO1	3	3	3	3	2	3	2	2	2	2	2	1	2.3
CO2	3	3	3	3	3	2	1	3	3	2	1	1	2.3
CO3	3	3	3	3	2	2	1	2	2	3	2	1	2.25
CO4	3	2	3	2	3	3	1	2	2	3	2	1	2.25
CO5	3	3	2	3	2	3	3	3	3	3	3	2	2.75
	Mean Overall Score												2.37
	Correlation												High

3 – Strong, 2- Medium, 1- Low

Mean Overall Score	Correlation
<=1	Low
>1 & <=2	Medium
>2 & <=3	High