15B12MA481 BIOSTATISTICS LAB

Lectures 3 Tutorials 1 Practical 2 ***Credits 5***

Computer Lab Sessions: It aims to develop computer programs for various probability and statistical concepts/procedures.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	Marks	Duration
Mid Semester Exam	50	2 Hours
End Semester Exam	50	2 Hours
Total	100	

Course Outcomes:

CO1: Write and execute the programs to calculate correlation and regression coefficients.

CO 2: Write and execute the programs to calculate least squares estimates.

CO 3: Write and execute the programs to perform run tests, signed-rank tests, Wilcoxon test, Kruskal-Wallis and Friedman's test.

CO 4: Write and execute the programs to obtain probability distributions for Poisson's process.

CO 5: Write and execute the programs to obtain probability distributions for Markov chains

CO 6: Write and execute the programs for clustering and applications.

Model computer-based exercises:

1. To write a program to calculate correlation and simple linear regression coefficients. **[CO 1]**
2. To write a program to calculate least squares estimates for linear regression using method of least squares/normal equations. **[CO 2]**
3. To write a program to calculate least squares estimates for multivariate linear regression coefficients, using matrix method. **[CO 2]**
4. To write a program to calculate least squares estimates for multivariate polynomial regression coefficients.**[CO 2]**
5. To write a program to perform Run test for randomness for given data. **[CO 3]**
6. To write a program to perform Sign test and Signed-rank for one sample and two samples for given data. **[CO 3]**
7. To write a program to perform and Wilcoxon test (Mann-Whitney test) test for given data. **[CO 3]**
8. To write a program to perform Kruskal-Wallis test and Friedman's test for given data. **[CO 3]**
9. To write a program to obtain probability distribution for Poisson process for given arrival rate and time-interval with a specified detecting probability. **[CO 4]**
10. To write a program to obtain one-step and n-step transition probability distributions for a given homogeneous Markov chain. **[CO 5]**
11. To write a program to obtain steady state probability distribution for a given homogeneous Markov chain with n states. **[CO 5]**
12. To write a program for hierarchical agglomerative (Bottom-up) clustering and display results in the form of a dendrogram. **[CO 6]**

13. To write a program for hierarchical divisive (Top-down) clustering and display results in the form of a dendrogram. **[CO 6]**
14. To write a program to demonstrate partitioning clustering using k-means algorithm. **[CO 6]**
15. To write a program to demonstrate partitioning clustering using k -medoids algorithm. **[CO 6]**

Note: Students are required to verify the computer programs through the statistical software packages: R, **SPSS, Minitab and Excel.**

10B11MA421 BIOSTATISTICS

Lectures 3 Tutorials 1 Practical 2 ***Credits 5***

Pre-requisites: Probability and Statistics (10B11MA311)

Objective:

- To study multiple linear regression and correlation model
- To study non-parametric tests, clustering and stochastic process along with their application in Bio-informatics.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes:

CO1: Perform correlation and regression analysis and draw conclusions and apply to Bio-informatics models.

CO 2: Use method of least squares and evaluate least squares estimates.

CO 3: Execute non parametric tests and run tests and draw conclusions.

CO 4: Understand stochastic processes and find ensemble averages, mean function, auto Correlation and auto-covariance functions, SSS and WSS processes.

CO 5: Understand the Markov chains and apply Markov processes.

CO 6: Apply clustering algorithms and its applications to large databases and use clustering with categorical attributes.

Regression and correlation: Introduction – linear regression and multiple regression (linear & polynomial). Normal regression analysis – estimation of regression coefficients and confidence intervals. Normal correlation analysis - method of maximum likelihood. Multiple linear regression (*method of least squares* and *matrix notation*). **[CO 1][8 L]**
Method of least squares - normal equations and least squares estimates**. [CO 2][2 L]**

Non-parametric tests: Need of non-parametric tests. Sign test for one sample and two samples, signed-rank test, Wilcoxon test (Mann-Whitney test), Run test for randomness. Distribution-free ANOVA: Kruskal-Wallis and Friedman's test**. [CO 3][9 L]**

Stochastic Processes: Introduction and classification of stochastic processes. Ensemble averages – mean function, auto-correlation function, auto-covariance function. Stationary processes – strict-sense stationary (SSS) process and wide-sense stationary (WSS) process. **[CO 4][6 L]**
Markov processes - Markov chains – Markov property, transition probability matrix, state-diagram. Processes with independent increments - Poisson process. Modeling (applications of Markov chains in Bio-informatics). Brownian motion – simple random walk. **[CO 5][6 L]**

Clustering: Definition and meaning, similarity and distance measures, outliers. Clustering algorithms: hierarchical (agglomerative & divisive) and partitioning (k-means & k-medoids). Clustering large databases, clustering with categorical attributes, comparison. **[CO 6][11 L]**

Text Books:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye: ``Probability and statistics for engineers and scientists'', Pearson, Nineth edition, 2011.
2. T. Veerarajan: ``Probability, statistics and random processes", Tata McGraw-Hill, Third edition, 2008.
3. M. H. Dunham: ``Data mining: Introductory and advanced topics", Pearson, 2012.

Reference Books:

1. Wayne W. Daniel: ``Biostatistics: A foundation for analysis in the health sciences'', John Wiley & Sons, Nineth edition, 2008.
2. Jay L. Devore: ``Probability and statistics for engineering and the sciences", Cengage Learning, Eight edition, 2011.
3. W. J. Ewens and G. R. Grant: ``Statistical methods in bioinformatics", Springer 2001.
4. Alan Agresti and Barbara Finlay, ``Statistical methods for the social sciences", Pearson prentice hall, Fourth edition, 2009.

<u>Computer Lab Sessions</u>: It aims to develop computer programs for various probability and statistical concepts/procedures.

Model computer-based exercises:

1. To write a program to calculate correlation and simple linear regression coefficients. **[CO 1]**
2. To write a program to calculate least squares estimates for linear regression using method of least squares/normal equations. **[CO 2]**
3. To write a program to calculate least squares estimates for multivariate linear regression coefficients, using matrix method. **[CO 2]**
4. To write a program to calculate least squares estimates for multivariate polynomial regression coefficients.**[CO 2]**
5. To write a program to perform Run test for randomness for given data. **[CO 3]**
6. To write a program to perform Sign test and Signed-rank for one sample and two samples for given data. **[CO 3]**
7. To write a program to perform and Wilcoxon test (Mann-Whitney test) test for given data. **[CO 3]**
8. To write a program to perform Kruskal-Wallis test and Friedman's test for given data. **[CO 3]**
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12. To write a program for hierarchical agglomerative (Bottom-up) clustering and display results in the form of a dendrogram. **[CO 6]**
13. To write a program for hierarchical divisive (Top-down) clustering and display results in the form of a dendrogram. **[CO 6]**
14. To write a program to demonstrate partitioning clustering using k-means algorithm. **[CO 6]**
15. To write a program to demonstrate partitioning clustering using k -medoids algorithm. **[CO 6]**

Note: Students are required to verify the computer programs through the statistical software packages: R, **SPSS, Minitab and Excel.**

DISCRETE MATHEMATICS (10B11MA211)

Core course **Credits 4**
Lectures 3 Tutorials 1 Practical 0

Course Objectives: The objectives are to study:

- Various discrete structures (e.g., sets, relations, graphs, trees, etc.) that provide the mathematical formalizations for computational problems.
- Mathematical arguments and proof techniques.

Course Assessment:

Test 1	15 Marks	1 Hour
Test 2	25 Marks	1.5 Hours
Test 3 (End Semester Exam)	35 Marks	2 Hours
Course work + Attendance	20+5=25 Marks	Continuous evaluation
Total	**100 Marks**	

Syllabi Coverage:

1. Test 1 Syllabi covered up-to T-1.
2. Test 2: (Mid Term) Syllabi covered up to T-2 (including T1 syllabus).
3. End Semester Exam: Entire Syllabus.

Course Outcomes (CO):

Students that successfully complete this course will be able to:

CO1: Understand set operations, Principle of Mathematical Induction, various types of relations & their representations.
CO2: Solve problems related to Pigeon-hole principle, recurrence relations, Propositions and quantifiers.
CO3: Understand various types of graphs, paths, Graph colorings, Trees, Rooted trees & MST algorithms.
CO4: Understand Ordered Sets, Lattices.
CO5: Recognize Algebraic structures; Groups, Subgroups, Rings, Fields etc.
CO6: Comprehend Languages, grammars, finite state automata & finite state machines.

Detailed Syllabi

Sets and their algebra: Sets and their algebra, duality, power sets and partitions. Principle of Strong Mathematical Induction, Product sets, relations and their composition. Pictorial, matrix representation, Equivalence relations, types of functions, Composition of functions, Characteristic function of a set, Recursive functions. [CO1] [8L]

The Principle of Inclusion-Exclusion, The Addition and Multiplication Rules, The Pigeon-Hole Principle, Solving Recurrence Relations, Simple and compound statement. logical operators. Implication and double implication, Tautologies and contradictions. Valid arguments and fallacy. Propositional functions and quantifiers. [CO2] [8L].

Graphs: Graphs and related definitions, Various types of graphs, Subgraphs, isomorphism, paths and connectivity. Eulerian graph and Konigsberg problem. Hamiltonian graph, Covering; Matching. Independent sets; Planar Graphs, Homeomorphism, Kuratowski's theorem, Graph colorings. Four color problem, Digraphs and related definitions, connectivity in diagraphs, Trees, Rooted trees. Minimum Spanning Trees, Algebraic expressions and Polish notation. Sequential representation. Sequential representation. Adjacency matrix. Path matrix. Shortest path. [CO3] [14L].

Ordered Sets and Lattices: Ordered Sets and Lattices: Partial order relations and Hasse diagram, Supremum and infimum, total ordering, lattices – bounded, distributive, complemented, modular, Product of lattices. [CO4] [4L].

Algebraic structures: Binary operations, Algebraic structures – semigroup, monoid, groups, subgroups and their homomorphism. Rings, Integral domain and fields, Polynomials over a field. [CO5] [4L].

Introduction to Languages: Introduction to Languages, finite state automata grammars, finite state machines. [CO6] [4L].

Recommended Reading:	
1.	Kenneth H. Rosen: Discrete Mathematics and Its Applications with combinatorics and Graph Theory), Seventh Edition, Tata McGraw Hill 2011.
2.	Kolman B., Busby R., Ross S.: Discrete Mathematical Structures, Sixth Edition, Pearson Education 2009.
3.	Deo, N. : Graph Theory, Prentice Hall, 2004.
4.	Liu, C. L.: Elements of Discrete Mathematics, Third Edition, Tata McGraw-Hill 2008.

10B11MA111 **MATHEMATICS I** (***Core Course***)

Credits 4

Lectures 3 Tutorials 1 Practical 0

Pre-requisites:

Objectives: The objectives are to study

- various techniques of calculus and vector calculus - geometry of three dimensions, to study the basics of differential equations with constant coefficients
- the fundamentals of Laplace transformation and their applications
- the concepts of matrices to understand and solve the linear systems

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: Students that successfully complete this course will be able to:

CO 1: Evaluate partial derivatives with its physical significance and expand functions of several variables.

CO 2: Find maxima and minima of functions of several variables with / without constraints.

CO 3: Find areas and volumes of solids using multiple integration.

CO 4: Understand the calculus of vectors and vector valued functions with their physical significance

CO 5: Solve linear ordinary differential equations with constant coefficients.

CO 6: Use Laplace transforms and inverse Laplace transforms to solve IVP.

CO 7: Solve linear systems of equations and perform diagonalization of matrices.

Topics Covered:

Calculus and Analytical Geometry: Partial differentiation - chain rules, change of variables. Taylors series for functions of two or more variables**.[CO 1][6 L]**

Maxima and minima, Jacobians.**[CO 2] [4 L]**

Double integrals - change of order and change of variables, Applications to areas and volumes**.[CO 3][5 L]**

Equations to a line and a plane (preferably using vectors). Equations to curves and surfaces. Line and surface integrals. Gradient, divergence and curl, their physical significance and expressions in spherical and cylindrical coordinates. Green's Theorem**.[CO 4][9 L]**

Differential Equations: Differential Equations with constant coefficients. Equations of the form y" = f(y). **[CO 5][6 L]**

Laplace Transform. Inverse Laplace transform. Dirac delta and unit-step function. Solution of initial value problems**.[CO 6][5 L]**

Matrices: Algebra of matrices, elementary row transformations and row echelon form. Determinant of a matrix. Solution of a system of equations by Gauss elimination. Rank and linear dependence. Eigenvalues and vectors of a square matrix, symmetric matrices, Reduction to diagonal form, Quadratic forms**.[CO 7][7 L]**

Books:

1. Thomas, G.B. and Finney, R.L. : Calculus and Analytical Geometry, 9^{th} Ed., Addison Wesley, 1996.
2. Prasad, C. : (a) Mathematics for Engineers
(b) Advanced Mathematics for Engineers, Prasad Mudralaya 1982.
3. Lipschutz, S. and Lipson, M. : Linear Algebra, 3^{rd} Ed., Schaum Series 2001.
4. Simmons, G. F. : Differential Equations with Applications, 2^{nd} Ed., McGraw Hill 1991.

10B11MA201 **MATHEMATICS II** **(*Core Course*)**

Credits 4

Lectures 3 Tutorials 1 Practical 0

Pre-requisites: 10B11MA111 Mathematics I

Objective:

The objectives are to study

- The various methods of solving the second order differential equations with variable coefficients, to study the basic properties of Bessel Functions, Legendre polynomials, Chebyshev polynomials and their Applications.
- To obtain solutions of Laplace, Wave and Diffusion equations in Cartesian, cylindrical and spherical coordinate systems.
- To study calculus of complex variables.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1.5 Hour
End Semester Exam	35	2 Hours
Total	100	

Syllabi Coverage:

1. Test 1 Syllabi covered up-to T-1.
2. Test 2: (Mid Term) Syllabi covered up to T-2 (including T1 syllabus).
3. End Semester Exam: Entire Syllabus.

Course Outcomes (CO):

Students that successfully complete this course will be able to:

CO 1: Solve problems related to convergence of series
CO 2: Understand Series solution of DEs
CO 3: Comprehend certain special functions e.g. Bessel, Legendre and Chebyshev
CO 4: Solve Heat equation, wave equation, Laplace equation
CO 5: Understand Functions of a complex variable, Analytic functions, Contour integration
CO 6: Solve problems based on Taylor's and Laurent's series, Cauchy residue theorem.
CO7: Evaluate certain real definite and improper integrals.

Topics Covered:

Infinite Series: Convergence of series, convergence tests. Absolute and uniform convergence [CO1] [4L]

Differential Equations: Introduction to second order linear differential equations with variable coefficients, Solution in series. [CO2] [4L]

Bessel and Legendre functions, Chebyshev polynomials, Orthogonality. [CO3] [8L]

Second order partial differential equations and their classification. One dimensional wave and diffusion equations and their applications. Laplace equation. [CO4] [6L]

Complex Variables : Functions of a complex variable. Analytic functions and Cauchy-Riemann equations. Conformal mapping, Complex Integration [CO5] [10L]

Taylor's and Laurent's series, Poles and singularities. Cauchy residue theorem. [CO6] [4L]

contour integration and their applications. [CO7] [6L]

Text Books:

1. Kreyszig, Erwin : Advanced Engineering Mathematics, John Wiley & Sons, Inc.
2. Jain and Iyengar : Advanced Engineering Mathematics, Narosa Publishing House

Reference Books:

3. Simmons, G.F. : Differential Equations with Applications, 2nd Ed, McGraw-Hill, 1991.
4. Brown, J.W., Churchill, R.V. : Complex Variables and Applications, 6th Ed., McGrawHill, 1996.
5. Spiegel, Murray R. : Theory and Problems of Complex variables Schaum's series
6. Sneddon I. N. : Introduction to Partial Differential Equations

10B11MA312 NUMERICAL METHODS L T P (3 1 0)

Offered to B.Tech. III Semester (Civil)

Pre-requisites: Basics of linear algebra (10B11MA111) and differential equations (10B11MA201).

Objective: The primary objectives of the course are

to provide the students a basic knowledge of expressing the engineering problems mathematically and to study various numerical techniques for solving problems that arise in science and engineering.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: Students that successfully complete this course will be able to:

CO 1: Find the roots of the nonlinear equations and system of nonlinear equations.

CO 2: Solve the system of linear equations using Direct methods and find Eigenvalues.

CO 3: Perform interpolation of a polynomial using various techniques.

CO 4: Perform Cubic-spline interpolation and approximations

CO 5: Perform Numerical Differentiation, Numerical Integration and find double integration.

CO 6: Solve initial value problems and boundary value problems.

CO 7: Find Numerical solutions of parabolic, elliptic and hyperbolic partial differential equations.

Topic covered:

Non-linear Equations: Root-finding methods: single nonlinear equation - Bisection method, False-Position method, Newton-Raphson and Secant methods, Simple Fixed-point Iteration method;more than one nonlinear equations - Newton's method. Convergence criteria. Iterative methods and the formula for calculation of the approximation **[CO 1][6 L]**

Numerical Linear Algebra: Direct methods: Gauss-elimination and LU-Decomposition methods. Iterative methods: Gauss-Siedel and Successive Over-Relaxation (SOR) methods. Eigenvalue problem: Power method for largest eigenvalue, Jacobi's method for symmetric matrices. **[CO 2][6 L]**

Interpolation & Approximation: Interpolating polynomial. Lagrange formula with error. Formulae for equispaced points. Divided differences: Newton's interpolating polynomials. Hermite interpolation. **[CO 3][5 L]**

Cubic-spline interpolation. Pade and rational approximations. Least square approximation. Approximation by splines. **[CO 4][5 L]**

<u>Numerical Differentiation and Quadrature</u>: Approximation of derivatives, Newton-cote i**ntegration** formulae.Gauss-Legendre quadrature formulae. Romberg integration. Double integration. **[CO 5][9 L]**

<u>Numerical Solutions of ODE and PDE:</u> Runge-Kutta and Predictor corrector methods for IVPs. The Finite difference method and Shooting method for BVPs. **[CO 6][6 L]**

Numerical solutions of parabolic, elliptic and hyperbolic partial differential equations.

[CO 7][5 L]

Books:

1. P. Kandasamy, K. Thilagavathy and K. Gunavathy, “Numerical Methods”, S. Chand Co. Ltd., New Delhi, 2003.

2. C.F. Gerald and P.O Wheatley, “Applied Numerical Analysis”, Sixth Edition, Pearson Education Asia, New Delhi, 2002.

References:

3. C. Xevier, **C Language and Numerical Methods**, New Age International, 2008.
4. H. Press, S. A. Teukolsky, W.T. Vellerling, and B.P. Flannery, **Numerical Recipes in C**, 2^{nd} Ed., Cambridge University Press, 1992.
5. *B. S. Grewal,* **Numerical Methods**, *Khanna Publishers, New Delhi, 1998.*

Lab sessions: It consist development of computer programs for various numerical techniques/methods and their use as sub-routines. Develop and execute the following programs using C-language:

1. Find the roots of non-linear equation using Bisection method.
2. Find the roots of non-linear equation using Regula-Falsi method.
3. Find the roots of non-linear equation using Newton-Raphson method.
4. Find the function value at a particular value by Lagrange’s method of interpolation.
5. Find the function value at a particular value by Newton’s method of interpolation.
6. Solve the system of linear equations by Gauss elimination method.
7. Solve the system of linear equations by Gauss-Seidel iteration method.
8. Solve the system of linear equations by Gauss-Jordan iteration method.
9. Obtain a best-fit to the given data points using least-squares approximation.
10. Find the value of a definite integral of a function using Trapezoidal rule.
11. Find the value of a definite integral of a function using Simpson’s rule.
12. Find the value of derivative of a function at a specified value.
13. Obtain the largest eigenvalue of a matrix by means of power method.
14. Obtain a numerical solution of ordinary differential equation by Euler’s method.
15. Obtain a numerical solution of ordinary differential equation by Runge-Kutta method.

10B11MA311 PROBABILITY AND STATISTICS

Lectures 3, Tutorials 1, Practical 2 ***Credits 5***

For BI and BT

Pre-requisites: Working knowledge of basic calculus and combinatorial skills.

Objective: This course introduces students

- to the elementary concepts of descriptive and inferential techniques of statistical methodology.
- to extend and formalize knowledge of the theory of probability and random variables.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: At the end of the course, the students will be able to apply appropriate statistical concepts, methodologies and technologies in organizing, analyzing and interpreting various real-world situations and in coming up with relevant decisions:

CO-1	Compute and interpret measures of central tendency and dispersion of data; Construct and analyze graphical displays (histogram, bar & pie charts, etc.) to summarize data.
CO-2	Construct sample spaces of random experiments; identify and specify events; apply discrete/continuous probability distributions to evaluate event probabilities; use *central limit theorem* to find probabilities for sampling distributions.
CO-3	Conduct hypotheses tests & construct point & confidence-interval estimates concerning population parameters based on sample data; perform and interpret chi-square test of goodness-of-fit and test of independence.
CO-4	Compute correlation coefficient to decide the linear relationship that may exist between two variables of interest; find the equation of regression line and predict the value of one variable based on the value of the other variable.
CO-5	Identify and evaluate common sampling techniques such as F-test in ANOVA - evaluating or approximating the P-value of the test statistic - and design simple experimental; Identify key parts of a control chart and plot data on a control chart and interpret.

Probability & Statistics (10B11M311) CO Revised

Topics Covered:

Basics of statistics: Population, sample, attribute and variable (discrete and continuous). Classification and tabulation of data. Graphical representation of data - histogram, frequency polygon, frequency curve, cumulative frequency curve, stem-and-leaf plots, bar & pie charts. [CO-1]

Descriptive statistics: Measures of central tendency - mean, median, mode. Dispersion and its measures – range, quartile deviation, mean deviation, standard deviation. Skewness and kurtosis. [CO-1]

Probability: Random experiment, sample space, event, types of events. Three approaches to probability, additive and multiplicative laws of probability, conditional probability, total probability theorem and Bayes' theorem. [CO-2]

Random variable: Random variable (discrete and continuous), probability mass function, probability density function, and cumulative distribution function. Moments of random a variable - mean and variance. Moment generating function of a random variable. Bernoulli, binomial, Poisson, normal, exponential distributions and their applications. [CO-2]

Statistical inference: Introduction to random sampling. Concept of estimation. Hypotheses, type-I & type-II errors, test-statistic, critical value, critical region, confidence interval, level of significance, p-value. Test for mean and variance for single and double samples - Z-test, t-test and F-test. Chi-square test of goodness of fit and independence of attributes (mxn contingency). [CO-3]

Correlation and regression: Bivariate data, scatter plots. Pearson product-moment and Spearman's rank correlation coefficients, properties of correlation coefficient. Simple linear regression - regression equations, regression coefficients. [CO-4]

ANOVA and simple designs: One-way and two-way (without and with interaction) ANOVA. Concept of three basic principles of design of experiments, CRD and RBD. [CO-5]

Statistical quality control: Meaning, natural and tolerance limits. Control charts - $\bar{x}$, R, p, and c charts. [CO-5]

Text books:

1. Richard A. Johnson Irwin Miller and John E. Freund, ``Probability and Statistics for Engineers", Prentice Hall, New Delhi, 11th Edition, 2011.

Reference Books:

2. Ronald E. Walpole , Raymond H. Myers , Sharon L. Myers and Keying E. Ye, ``Probability and statistics for engineers and scientists'', 9th Edition, Pearson, 2011.

3. Jay L. Devore, ``Probability and statistics for engineering and the sciences", Cengage Learning, 8th Edition, 2011.

4. P. Kousalya, ``Probability, statistics and random processes", Pearson Education, 2013.

10B11MA411 PROBABILITY THEORY AND RANDOM PROCESSES

Lectures 3 Tutorials 1 Practical 2 ***Credits 5***

For CSE, ECE and IT

Pre-requisites: Basic knowledge of calculus-based integration (10B11MA111)

Objective: To provide the students with knowledge about the random variable, random process to build and analyze probabilistic models in both the discrete and continuous contexts of engineering applications.

Course Assessment:

Teacher Assessment (Based on Assignments, quizzes etc.)	25	Duration
Test 1	15	1 Hour
Test 2	25	1 Hour 30 Min
End Semester Exam	35	2 Hours
Total	100	

Course Outcomes: On successful completion of this course, the students should will be able to gain enough knowledge and understanding of the essentials of the probability and random processes; able to identify and associate a suitable probability model for a problem in reality:

CO-1	Construct sample spaces of random experiments; identify and specify events, and perform set operations on events; compute probabilities by counting; evaluate conditional probability, and apply Bayes' theorem to simple situations.
CO-2	Understand the axiomatic approach of probability theory and intrinsic need of (functions of) random variables for the analysis of random phenomena; express discrete random variables by using CDFs, PMFs; calculate moments related to random variables; understand the concept of inequalities and probabilistic limits; compute reliability measures associated with a system.
CO-3	Compute probability distributions and correlation measures of bivariate random variables; obtain marginal and conditional distributions of random variables; find probabilities for outcomes of various events related to an uncertain phenomenon using appropriate probability distributions as models.
CO-4	Identify and classify random processes and determine covariance and spectral density of stationary random processes; demonstrate specific applications to special processes such as Poisson, discrete-time Markov chain, and Gaussian processes - identify appropriate stochastic process model(s) for a given applied problem.

Probability and Random Processes (10B11MA411) CO Revised

Probability: Random experiments, sample space, events. Three basic approaches to probability, combinatorial probability problems. Conditional probability, total probability theorem, Bayes' theorem. [CO-1]

Random variables: Univariate random variables – discrete, continuous and mixed random variables, probability distributions (mass function, density function and cumulative distribution function and conditional distributions). Mathematical expectation, moments and moment generating function and characteristic function of random variables. Chebyshev's inequality. Bivariate random variables - joint, marginal, conditional distributions and generating functions, covariance and correlation. Transformations of random variables - distribution function technique, inverse mappings and method of moment generating function. [CO-2, CO-3]

Special distributions: Bernoulli, binomial, Poisson, exponential, gamma, Earlang, Chi-square, geometric, negative binomial, uniform, beta, normal, log-normal, Rayleigh, Rician and Weibull distributions. [CO-2, CO-3]

Reliability: Introduction, reliability measures - reliability function, hazard rate function, mean-time-to-failure (MTTF), residual life with the reliability models of exponential and weibull distributions. [CO-2]

Random processes: Introduction and classification of random processes. Ensemble (statistical) averages – mean function, autocorrelation (crosscorrelation) function, autocovariance (crosscovariance) function. Stationary processes – strict-sense stationary (SSS) process and wide-sense stationary (WSS) process with properties of autocorrelation function. Ergodic processes – time averages. Markov processes - Markov chains – transition probability matrix, state-diagram and steady-state probabilities. Processes with independent and stationary increments: Poisson process with-distributions of interarrival and waiting times, Brownian motion – simple random walk. Gaussian process - covariance matrix. Linear system with random inputs - system in the form of convolution, power spectral density, noise in communication systems, white Gaussian noise and idea of filters. [CO-4]

Text Books:

1. Oliver C. Ibe: ``Fundamentals of applied probability and random processes", Academic press, 2005.
2. A. Papoulis and S. U. Pillai: ``Probability, random variables and stochastic processes", Tata McGraw-Hill, 4th Edition, 2002.

Reference Books:

1. Henry Stark and John W. Woods: ``Probability and random processes with applications to signal processing'', Pearson education, 3rd edition, Asia, 2002
2. T. Veerarajan: ``Probability, statistics and random processes", Tata McGraw-Hill, 2008.