

Discipline Specific Elective
Category-V

DISCIPLINE SPECIFIC ELECTIVE COURSE – 3A: ACTUARIAL STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Actuarial Statistics	4	3	0	1	Class XII pass with Mathematics	NIL

Learning Objectives

The learning objectives include:

- To learn basics of Actuarial Science.
- To learn advanced techniques in Actuarial Science with practical applications in daily life.

Learning Outcomes:

After completing this course, students will develop a clear understanding of:

- Basics of Actuarial Science.
- Tools for applying actuarial methods in phenomena for financial research and insurance.
- computation of premiums and settlement of claims

SYLLABUS OF DSE-3A

Theory

UNIT I

(9 Hours)

Introductory Statistics and Insurance Applications

Introductory Statistics and Insurance Applications: Discrete, continuous and mixed probability distributions. Insurance applications, sum of random variables. Utility theory: Utility functions, expected utility criterion, types of utility function, insurance and utility theory.

UNIT II

(12 Hours)

Principles of Premium Calculation

Principles of Premium Calculation: Properties of premium principles, examples of premium principles. Individual risk models: models for individual claims, the sum of independent claims, approximations and their applications.

UNIT III

(6 Hours)

Survival Distribution and Life Tables:

Survival Distribution and Life Tables: Uncertainty of age at death, survival function, time-until-death for a person, curate future lifetime, force of mortality, life tables with examples, deterministic survivorship group, life table characteristics

UNIT IV

(15 Hours)

Life Insurance

Life Insurance: Models for insurance payable at the moment of death, insurance payable at the end of the year of death and their relationships. Life annuities: continuous life annuities, discrete life annuities. Premiums: continuous and discrete premiums.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Risk computation for different utility models.
2. Discrete and continuous risk calculations.
3. Calculation of aggregate claims for collective risks.
4. Calculation of aggregate claim for individual risks.
5. Computing Ruin probabilities and aggregate losses.
6. Annuity and present value of contract.
7. Computing premium for different insurance schemes.
8. Practical based on life models and tables.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Dickson, C. M. D. (2005): Insurance Risk And Ruin (International Series On Actuarial Science), Cambridge University Press. Bowers, N. L., Gerber, H. U., Hickman,
- Atkinson, M.E. and Dickson, D.C.M. (2011): An Introduction to Actuarial Studies, Elgar Publishing.

SUGGESTIVE READINGS

- J. C., Jones, D. A. And Nesbitt, C. J. (1997): .Actuarial Mathematics, Society Of Actuaries, Itasca, Illinois, U.S.A.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE– 3B: SIMULATION TECHNIQUES IN STATISTICS (Not for category II)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Simulation Techniques in Statistics	4	3	0	1	Class XII pass with Mathematics	knowledge of basic statistics

Learning Objectives

The learning objectives include:

- The objective of this course is to introduce the nuances of techniques involved in simulation studies as applicable to modeling of systems.
- The programming implementations will be completed using C/MATLAB/R/Python.

Learning Outcomes

After completing this course, students will possess skills concerning:

- Use of simulation to understand the behavior of real world systems.
- Ability to generate Pseudo-random numbers by the different methods.
- Random variable generation from theoretical distributions.
- Use of Monte Carlo methods and regenerative simulation.
- Ability to develop programs for the purpose of simulation.

SYLLABUS OF DSE- 6d

Theory

UNIT I

(12 Hours)

Introduction to simulation

Introduction, Systems, Simulation models, Classification of simulation models; Simulation and Monte Carlo Methods, Pseudo-random number generators; Statistical tests of Pseudo-random numbers.

UNIT II

(18 Hours)

Generation of random numbers

Random number generation. Random variable generation- Inverse transform method, Composition method, Acceptance-Rejection method. Generating from common statistical distributions- Discrete and Continuous. Simulation of random vectors, Generating Poisson processes and Markov chain.

UNIT III

(15 Hours)

Applications of simulation

Discrete event simulation; Monte Carlo integration; Variance reduction techniques; Applications to statistical inference; Point Estimators, Confidence Intervals and hypothesis tests.

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

PRACTICAL/ LAB WORK – (30 hours)

List of Practical:

1. Pseudo random number generators.
2. Generation of $U(0, 1)$.
3. Problems based on statistical tests.
4. Application to standard statistical distributions (discrete and continuous):
 - (a) The inverse transforms method.

- (b) Acceptance-Rejection method.
5. Problems based on Composition Method.
 6. Problems based on Monte Carlo integration.
 7. Problems based on Regenerative methods.

ESSENTIAL READINGS:

- Rubinstein, R.Y. (2017). Simulation and the Monte Carlo Methods, Wiley.
- Voss, J. (2014). An introduction to statistical computing: a simulation-based approach, Wiley series in computational statistics.
- Sheldon M. Ross (2022) Simulation, Sixth Edition, Elsevier Academic press publication.
- Averill M. Law and W. David Kelton (1991). Simulation modeling and analysis: McGraw-Hill, Inc., New York.

SUGGESTED READINGS:

- Reitman, J. (1971). Computer simulation Applications, John Wiley & Sons.
- Swarup, K. Gupta, P.K. and Mohan, M. (2014). Operations Research, 15th Ed, Sultan Chand & Sons.
- Fishman, G.S. (1996). Monte Carlo-Concepts, Algorithms and Applications, Springer.
- Sheskin, D. J. (2011). Handbook of parametric and nonparametric statistical procedures, CRC Press. Boca Raton, FL.

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DISCIPLINE-SPECIFIC ELECTIVE COURSE–3C: ENVIRONMENTAL STATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Environmental Statistics	4	3	0	1	Class XII pass with Mathematics	knowledge of sampling distributions and linear models

Learning Objectives

The learning objectives include:

- To study the role of Statistics in Environmental Science.

- To study different Statistical distributions, sampling procedures, linear models and analysis of variance.
- To study environmental monitoring.
- To study time-series analysis and Spatial-data analysis.
- To learn about censored data and risk assessment.

Learning Outcomes:

After completing this course, students will develop a clear understanding of:

- The role of Statistics in Environmental Science.
- Uses and applications of different Statistical distributions, sampling procedures, linear models and analysis of variance.
- Environmental monitoring.
- Time-series analysis and Spatial-data analysis.
- Censored data and risk assessment.
- They will be able to do risk analysis using spreadsheet.

SYLLABUS OF DSE – 3C

Theory

UNIT I: (9 hours)

Introduction

The Role of Statistics in Environmental Science: Introduction, Examples, Base-line, Targeted, Regular monitoring, Role of Statistics in Environmental Science. Environmental Sampling: Introduction, Sampling Procedures, Sampling in the wild.

UNIT II: (9 hours)

Models for Data and Environmental Monitoring

Models for Data: Statistical models, Discrete statistical distribution, Continuous statistical distributions, Linear Models, ANOVA. Environmental Monitoring: Detection of changes by ANOVA, Detection of changes using control chart, Chi squared tests for a change in a distribution.

UNIT III: (9 hours)

Time Series and Spatial-Data Analysis

Introduction to Time Series Analysis, Components of Time Series, Serial correlation. Introduction to Spatial-Data Analysis, Types of spatial data, Spatial Patterns in quadrat counts, and Correlation between quadrat counts.

UNIT IV: (9 hours)

Censored Data and Risk Assessment:

Introduction to Censored Data, Single sample estimation, Types of censoring. Introduction to Risk Assessment, Principles for Monte Carlo Risk Assessment, Risk Analysis using spreadsheet.

PRACTICAL/LAB WORK - (30 HOURS)

List of Practical:

1. Collection of environmental data.

2. Fitting different discrete distributions. Case: Estimate the survival rates of salmon in rivers and continuous distributions,
3. Fitting regression model (simple and multiple), Case: Chlorophyll-a in lakes/ivers as an indicator of lake/river water quality, Soil, and Vegetation data.
4. Change detection in the environment using ANOVA, Control Charts, Hypotheses testing- Case: pH values, SO₄ concentrations etc in lakes/ivers, Annual ring widths in trees,
5. Time series analysis- Case: World Temperature data, Annual sunspot data, Rainfall data, or on any environmental issues.
6. Serial correlation- Case: Northern and Southern Hemisphere temperatures
7. Single sample estimation,
8. Correlation between quadrats counts- Case: Correlation between counts for two different species in a water body.
9. Analysis of censored environmental data,
10. Risk analysis- Case: Contaminant uptake in Tap-water

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS:

- Bryan F. J. Manly (2009): Statistics for Environmental Science and Management, 2nd Edition, Chapman and Hall.
- Barnett, Vic (2006): Environmental Statistics: Methods and Applications, Reprinted 2004, Wiley.

SUGGESTED READINGS:

- Milalrd, Steben P. and Neeranchal, Nagaraj K (2000): Environmental Statistics with S-plus, CRC Press.
- Gelfand Alan E. (2019): Handbook of Environmental and Ecological Statistics, Chapman and Hall, CRC Press.
- David Valerie (2019): Statistics in Environmental Sciences, Wiley.

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DISCIPLINE SPECIFIC ELECTIVE COURSE – 3d: REGRESSION ANALYSIS (Not for category I)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Regression Analysis	4	3	0	1	Class XII pass with Mathematics	knowledge of sampling distributions and matrix theory

Learning Objectives

The learning objectives include:

- Be able to carry out and interpret Correlation Analysis
- Be able to carry out and interpret inference procedures for simple linear regression.
- Know the simple and multiple linear regression models, and be able to state and explain the standard methods of estimation for these models.

Learning Outcomes:

After completing this course, students will develop a clear understanding of:

- Basic concept of matrix, its types and operations,
- correlation and regression techniques, the two very powerful tools in statistics,
- Linear and Multiple Linear regression,
- regression diagnostics, multicollinearity, residual plots and estimation and tests for regression coefficients.
- concept of coefficient of determination and inference on partial and multiple correlation coefficients.

SYLLABUS OF DSE-3d

Theory

UNIT I

(15 hours)

Introduction

Correlation, Types of correlation, Methods of studying simple correlation - Scatter diagram, Covariance between two variables: Definition, computation, effect of change of origin and scale, Karl Pearson's coefficient of correlation, Spearman's Rank correlation coefficient.

UNIT II

(15 hours)

Linear Regression

Linear Regression: Meaning of regression, difference between correlation and regression, simple linear regression model, Estimation of regression parameters by least squares method (fitting of regression

model), Interpretation of parameters. Test of significance of regression and confidence interval, Concept of residual, Residual plots, comparison of two models on the basis of residual sum of squares.

UNIT III

(15 hours)

Multiple Linear Regression

Multiple linear regression: Estimation of regression parameters by least square method and their properties, Interpretation of parameters. Concept of coefficient of determination R^2 and adj R^2 . Testing of hypothesis and bias in regression estimates.

PRACTICAL/LAB WORK – (30 hours)

List of Practical:

1. Computation of covariance, coefficient of correlation, checking for independence and uncorrelatedness of two variables.
2. Lines of regression, angle between lines and estimation of parameters.
3. Lines of regression and regression coefficients.
4. Spearman rank correlation with/without ties.
5. Fitting of simple linear regression model
6. Testing of hypothesis in SLRM
7. Fitting of multiple linear regression model
8. Testing of hypothesis in MLRM
9. Bias in regression parameters

Practical work to be conducted using electronic spreadsheet / EXCEL/ Statistical Software Package/ SPSS/ calculators.

ESSENTIAL READINGS

- Draper, N. R. and Smith, H. (1998). Applied Regression Analysis. 3rd Edition. John Wiley.
- Montgomery, D. C., Peck, E. A. and Vining, G. G. (2013). Introduction to Linear Regression Analysis. 5th Edition. Wiley.

SUGGESTIVE READINGS:

- Hosmer, D. W., Lemeshow, S. and Sturdivant R.X. (2013). Applied Logistic Regression, Wiley Blackwell.
- Neter, J., Kutner, M. H., Nachtsheim, C.J. and Wasserman, W. (1996). Applied Linear Statistical Models, 4th Edition, Irwin USA.
- Gun, A.M., Gupta, M.K. and Dasgupta, B. (2005). An Outline of Statistical Theory, Volume II, World Press.
- Arora, S. and Bansal, L. (1968). New Mathematical Statistics, 1st Ed., Vanita Printers.

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