Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
(Autonomous)
Course Structure for M.Sc. - II Semester- IV (STATISTICS)
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Semester	Paper Code	Title of the Paper	No. of Credits
IV	STAT-5401	Stochastic Processes	4
	STAT-5402	Statistical Process Control	4
	STAT-5403	Survival Analysis	4
	STAT-5404 (A) STAT-5404 (B) STAT-5404 (C)	Actuarial Statistics Or Reliability Theory Or Statistical Analysis of Micro-Array Data	4
	STAT-5405	Practical-VII	4
	STAT-5406	Project	4

Program Outcomes (POs) for M.Sc. Programme

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings.
PO4	**Research-related skills and Scientific temper :** Infer scientific literature, build a sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.

PO5	**Trans-disciplinary knowledge:** Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5401
Paper : I Title of Paper : Stochastic Processes
Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. To provide the students with a fundamental understanding of the stochastic processes.
2. To familiarize the students with the stochastic simulation techniques.
3. Students should be able to construct tpm, find the n-step transition probabilities and classify its states.
4. Students should be able understand the structures of the Poisson process, Renewal process and Wiener process and its special properties, applications.

B) Course outcomes:

Students will be able to:

CO1. develop a deep understanding of what stochastic processes are, including their definitions, characteristics, and mathematical representations.

CO2. understand stationary processes and its properties.

CO3. develop problem-solving skills of stochastic processes theory to practical problems.

CO4. explore the ethical implications of using stochastic processes in various fields.

CO5. perform stochastic simulations.

CO6. learn statistical packages for modeling and analyzing stochastic processes.

CO7. learn about continuous-time stochastic processes, including the Poisson process, Brownian motion, Wiener process and Renewal process.

TOPICS/CONTENTS:

Unit-1

Introduction to stochastic processes, classification of stochastic processes according to states space and time, Markov property, Markov Chains (MC), finite MC, transition probabilities, initial distribution, Chapman Kolmogorov equation, n-step transition probabilities, Transition Probability Matrix (T.P.M.), hitting times, probability of ever return, transient and recurrent states, decomposition of state space, closed set of states, irreducible set of states, irreducible MC, absorption probabilities, martingales, classification of states of birth and death chains, queuing chain, branching chain, random walk, gambler's ruin chain with absorbing ,

reflecting and elastic barrier, etc. probability of ruin cases (i) adversary is infinitely rich (ii) stakes are doubled or halved , expected gain, expected duration of the game. **(15 L)**

Unit- 2

Elementary properties of stationary distributions, illustrations such as birth and death chains, Ehrenfest chain, particles in box, average number of visits to recurrent state, non null and positive recurrent states, probability of absorption in persistent class starting from transient state, period of state, existence of uniqueness of stationary distributions: reducible chains, illustrations such as queuing chain finite chains, convergence to the stationary distribution. Steady state distribution, ergodic Markov chain, Ergodic theorem (Statement Only), Branching Chain: BGW branching process, offspring distribution, mean and variance, generating function for probability of ultimate extinction, n^{th} generation size and related recurrence relations. **(15L)**

Unit- 3

Poisson process: Postulates and properties of Poisson process, probability distribution of N(t) the number of occurrences of the event in (0,t], Poisson process and probability distribution of interarrival time, generalizations of Poisson process: pure birth process: Yule Furry process, Birth immigration process. Birth and death process: (i) immigration-emigration process, (ii) linear growth process, (iii) linear growth with immigration, (iv) immigration death process. (v) Pure death process. **(15 L)**

Unit- 4

Continuous Time Markov Chains (CTMC): Chapman Kolmogorov equations, limiting distributions, ergodicity of homogeneous Markov process. (c) Markov processes with continuous state space: Introduction to Brownian motion and its properties, Wiener process. Renewal process: renewal process in continuous time, renewal function and renewal density, renewal equation, stopping time: Wald's equation, elementary renewal theorem and its applications: (i) Age and block replacement policies, (ii) Replacement on failure and block replacement, renewal theorems (Blackwell's and Smith's): (i) Blackwell's theorems, (ii) Smith's theorem or Key Renewal theorem, Poisson process as renewal process, alternating or two stage renewal process.

(15 L)

References:

1) Medhi J. (1982) Stochastic processes (Wiley Eastern)
2) Ross, S. (1996) Stochastic processes (John Wiley)
3) Ross, S. (2000) Introduction to probability models, 7th edition (Academic Press)
4) Hoel , P.G.,Port, S.C. ,Stone, C.J. (1972) : Introduction to stochastic processes
5) Bhat, B.R. (2000) stochastic models: Analysis and applications (New Age International)
6) Adke, S.R., Manjunath, S.M. (1984) An introduction to finite Markov processes (Wiley Eastern)
7) Taylor, H N and Karlin, S. (1984) An introduction to stochastic modeling(Academic Press)

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3			3		1		1	3
CO2	3			3		1		1	3
CO3		3		3		1		1	3
CO4			2	3	2	1	2	1	3
CO5		2		3		1		1	3
CO6				3		1		1	3
CO7	3			3		1		1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Develop a deep understanding of what stochastic processes are, including their definitions, characteristics, and mathematical representations. (Weightage: 3 - Strongly Related)

Justification: Developing a deep understanding of stochastic processes directly aligns with building disciplinary knowledge in probability and statistics.

CO2. Understand stationary processes and their properties. (Weightage: 3 - Strongly Related)

Justification: Understanding stationary processes contributes to disciplinary knowledge in stochastic processes, covering important properties and concepts.

CO7. Learn about continuous-time stochastic processes, including the Poisson process, Brownian motion, Wiener process, and Renewal process. (Weightage: 3 - Strongly Related)

Justification: Learning about continuous-time stochastic processes enhances disciplinary knowledge, providing a broader understanding of stochastic modeling.

PO2. Critical Thinking and Problem Solving

CO3. Develop problem-solving skills of stochastic processes theory to practical problems. (Weightage: 3 - Strongly Related)

Justification: Problem-solving in stochastic processes involves critical thinking, connecting theoretical knowledge to practical applications.

CO5. Perform stochastic simulations. (Weightage: 2 - Moderately Related)

Justification: Stochastic simulations involve practical problem-solving, making this outcome moderately related to critical thinking.

PO3. Social Competence

CO4. Explore the ethical implications of using stochastic processes in various fields. (Weightage: 2 - Moderately Related)

Justification: Exploring ethical implications has a social dimension, making this outcome moderately related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of stochastic processes.

PO5. Trans-disciplinary Knowledge

CO4. Explore the ethical implications of using stochastic processes in various fields. (Weightage: 2 - Moderately Related)

Justification: Ethical considerations in using stochastic processes may have trans-disciplinary implications, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in stochastic processes, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO4. Explore the ethical implications of using stochastic processes in various fields. (Weightage: 2 - Moderately Related)

Justification: Exploring ethical implications is moderately related to effective citizenship and ethical considerations.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on stochastic processes methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Stochastic processes are a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5402

Paper : II Title of Paper : Statistical Process Control

Credit : 4 credits No. of lectures : 60

A) Course Objectives:

1. The main objective of this course is to understand the philosophy and basic concepts of quality improvement.
2. Students should be able Understand and interpret the basic concepts and usage of Six Sigma
3. Students should be able use the methods of statistical process control.

B) Course Outcomes:

Students will be able to

CO1. describe the DMAIC processes (define measure, analyze, improve, and control).

CO2. perform analysis of process capability and measurement system capability.

CO3. demonstrate the ability to design, use, and interpret synthetic and non-parametric control chart.

CO4. determine the "short" term stability and capability of a process.

CO5. learn about process capability indices (e.g., Cp, Cpk) and their interpretation, also assess the capability of a process to meet specifications.

CO6. learn about advanced control charts, like CUSUM charts and EWMA charts.

CO7. effectively communicate SPC results and recommendations to various stakeholders.

TOPICS/CONTENTS:

Unit- 1

a) Total quality Management: meaning and dimensions of quality, Quality improvement, Quality Philosophy, Introduction to TQM, Six sigma, DMAIC, and other extension of TQM, quality systems, The ISO 9000 and other Quality systems. Deming's PDCA cycle for continuous improvements and its applications.

b) Concepts of stable industrial processes, Systematic variation, random variation, variation within and between subgroups, estimation of process parameters, **(10 L)**

Unit- 2

a) Control Chart: Revision of control charts for attributes, S^2 chart, X -S chart with subgroup size (i) fixed, (ii) variable. Equivalence between control chart and testing of hypothesis problem. Operating characteristic (OC curve) of control chart. Average run length (ARL). Probability of false alarm, probability of catching shift in parameter. Comparison of control chart using ARL and OC curve. Patterns on control charts with justification and its effect on probability of false alarm. An application of control charts situations other than manufacturing.

b) Attribute control charts: Revision of control charts for attributes, OC curve for P chart and C chart. Determination sample size for P chart by various criteria (i) probability of catching at least 0.5 (ii) to get LCL >0 (iii) To have at least some defectives in sample with given confidence coefficient. (iv) Minimizing ATS () chart and OC Curve, U chart, Demerit control chart for number of defects. Nelsons control chart for low defect counts. General ideas of economic designing of control charts. Duncan's model for the economic control chart. **(15 L)**

Unit- 3

a) CUSUM chart:

Chart statistic ($_{Ci}^{+}$, $_{Ci}^{-}$)and chart parameters(k,h), construction and working of tabular CUSUM chart for mean and variance, Statement of hypotheses.Estimation of shift in mean of process, fast initial response or head start feature, Siegmund's approximation for ARL and determination of chart parameters.CUSUM chart for subgroup size n>1, comparison between Shewhart chart and CUSUM chart V mask procedure.

b) EWMA chart:

Chart statistic its expectation and variance. Choice of chart parameters (L). Construction and working of EWMA chart for mean and variance. EWMA chart for subgroup size n>1, Comparison of Shewhart control charts with CUSUM charts. Simulation of ARL ().

c) Process capability: Different Process capability and performance indices C_p, C_{pk}. C_{pm}. and relation between capability indices. Connection between proportion of defectives (DPPM) and C_p. Interval estimation of mean given C_{pm} 1. Estimation and confidence intervals of estimators of C_p and C_{pk} Testing of hypothesis about C_p. **(20 L)**

Unit- 4

a) Other control charts

(i) Synthetic control chart: Concept of run length, probability distribution of run length

Confirming run length (CRL) chart for attributes, Synthetic control chart, computations of chart parameters for given ARL (0), Zero State Performance, Steady state performance, Computations of ARL (), ATS ()., Comparison of with Shewhart control chart and CUSUM charts.

(ii) Non-parametric control chart: Concept, construction of non-parametric chart using sign test.

(iii) A distribution-free Shewhart Quality Control Chart Based on Singed-Rank

(iv) Control charts for auto correlated observations: Need, constructions of control chart for residuals after fitting first order auto correlated model.

b) Hoteling T^2Chart: Testing multivariate normality, Hotelling T^2multivariate control chart for mean vector when (i) dispersion matrix is (i) known (ii) unknown ARL (0), ARL (δ). Control chart for dispersion matrix when mean vector is (i) known (ii) unknown. T^2control chart when subgroup size n=1 **(15L)**

References:

1) Bourke P.D. (1991) Detecting shifts in fraction non – confirming using run length chart with 100% inspection. Journal of Quality Technology 23 (3) 225-230
2) Besterfield, D. H.Besterfield – Michana, c, Besterfield,G.H. Besterfield-Sace, M(2001) Total Quality Management ; Pearson Education(Singapore) Pte. Ltd. India 2nd Edition.
3) Logotheris, N. (1992) Managing Total Quality; Prentic Hall of India.
4) Montgomery ,D.C. (1985) Introduction to Statistical Quality Control (Wiley)
5) Oakland J.S. (1989) Total Quality Management: Butterworth – Heinemann.
6) Raid W. Amin **a** Marion R. Reynolds Jr. b; Bakir Saad c: Nonparametric quality control charts based on the sign statistic: Communications in Statistics - Theory and Methods Vol. 24(6), 1995.
7) Bakir S. T. : A distribution-free Shewhart Quality Control Chart Based on Singed-Ranks, Quality Engineering, Vol. 16(4), 613-623
8) Wu, Yeu and Spedding (2001) A synthetic control chart for detecting fraction non confirming increases JQT Vol. 33 (1), 104-111

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3		3	1	1	1	1	3
CO2	3	3		3	1	1	1	1	3
CO3	3	3		3	1	1	1	1	3
CO4	3	3		3	1	1	1	1	3
CO5	3	3		3	1	1	1	1	3
CO6	3	3		3	1	1	1	1	3
CO7	3	3	2	3	1	1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Describe the DMAIC processes (define, measure, analyze, improve, and control). (Weightage: 3 - Strongly Related)

Justification: Describing the DMAIC processes directly contributes to building disciplinary knowledge in the field of Six Sigma and process improvement methodologies.

CO2. Perform analysis of process capability and measurement system capability. (Weightage: 3 - Strongly Related)

Justification: Performing analysis of process and measurement system capability is fundamental to disciplinary knowledge in quality management and process improvement.

CO3. Demonstrate the ability to design, use, and interpret synthetic and non-parametric control chart. (Weightage: 3 - Strongly Related)

Justification: Designing, using, and interpreting control charts is a key aspect of disciplinary knowledge in statistical process control (SPC).

CO4. Determine the "short" term stability and capability of a process. (Weightage: 3 - Strongly Related)

Justification: Determining short-term stability and capability is an essential part of disciplinary knowledge in quality management and process improvement.

CO5. Learn about process capability indices (e.g., Cp, Cpk) and their interpretation, also assess the capability of a process to meet specifications. (Weightage: 3 - Strongly Related)

Justification: Learning about process capability indices and assessing a process's capability aligns directly with disciplinary knowledge in quality control.

CO6. Learn about advanced control charts, like CUSUM charts and EWMA charts. (Weightage: 3 - Strongly Related)

Justification: Learning about advanced control charts contributes to disciplinary knowledge in statistical process control, providing deeper insights into monitoring and improving processes.

CO7. Effectively communicate SPC results and recommendations to various stakeholders. (Weightage: 3 - Strongly Related)

Justification: Effective communication of SPC results is crucial for disciplinary knowledge, ensuring that insights are conveyed to stakeholders.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from understanding the DMAIC processes to interpreting advanced control charts.

PO3. Social Competence

CO7. Effectively communicate SPC results and recommendations to various stakeholders. (Weightage: 2 - Moderately Related)

Justification: Effective communication of results has a social dimension, making this outcome moderately related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of statistical process control.

PO5. Trans-disciplinary Knowledge

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on statistical process control methodologies than on trans-disciplinary aspects.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in statistical process control, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on statistical process control methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Continuous improvement and staying abreast of advancements in statistical process control require ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5403
Paper : III Title of Paper : Survival Analysis
Credit : 4 credits No. of lectures : 60

A) Course objectives:

1. Student should be able to decide the type of censoring and truncation that is the basis for given survival data.
2. Student should be able to estimate survival functions using parametric and non-parametric methods.
3. Student should be able to compare survival functions of two or more populations.
4. Student should be able to use software for survival analysis.

B) Course outcomes:

After completing this paper, the student will be able to:

CO1. identify applications with time to event outcomes.

CO2. construct a life table using the actuarial approach.

CO3. construct a life table using the Kaplan-Meier approach.

CO4. perform and interpret the log rank test.

CO5. compute and interpret a hazard ratio.

CO6. interpret coefficients in Cox proportional hazards regression analysis.

CO7. learn about censored and truncated data and understand how to handle these issues in survival analysis.

TOPICS/CONTENTS:

Unit-1

Meaning of censoring, concepts of time, order and random censoring (left and right), survival function, density function, hazard function (rate), cumulative hazard rate, mean residual life function, percentile residual life function, Equilibrium distribution function. Exponential distribution and it's no ageing properties: Lack of memory property, constant failure rate, Cauchy-function equation, constant mean residual life function ,TTT transform, identity function as a TTT transform, aging classes - IFR, IFRA, NBU, NBUE, DMRL, HNBUE and their duals, and inter relationship among these classes. Bathtub Failure rate, IFRA closure property, bound on reliability function of an IFRA distribution. **(15 L)**

Unit 2

Life distributions - Exponential Gamma, Weibull, Lognormal, Pareto, linear Failure rate, Makeham family, Lehman families (proportional hazard rate family), spacing, normalized spacing and results of an exponential distribution based on normalized spacing. Parametric inference for complete data: a) Exponential distribution: Point estimation of parameter of exponential distribution and Fisher information, exact and asymptotic Confidence Intervals for λ, obtaining minimal sufficient and consistent estimator of λ, and Graphical method for checking exponetiality of data. b) Weibull: Obtaining MLE of scale and shape parameter of Weibull distribution and sample information matrix. c) Gamma: Obtaining MLE of scale and shape parameter of Gamma distribution and sample information matrix. d) Lognormal: Obtaining MLE of of parameter μ and σ, Confidence Interval for μ and σ. **(15L)**

Unit 3

Parametric inference for censored data: 1) Type I censoring: Exponential distribution 2) Type II censoring: Exponential, gamma, Lognormal 3) Random censoring: Exponential, Lehman family, Weibull distribution, Non-Parametric estimation of survival Function a) For complete data: Non parametric estimator of distribution function and survival function, distribution of emperical survival function, confidence band for survival function (by Using Kolmogorov - Smirnov statistics) b) For censored data: Actuarial estimator of survival Function, Estimator of variance of actuarial estimator (Greenwoods formula), product limit estimator and its variance, redistribution to right algorithm. **(15L)**

Unit 4

Test for Exponetiality: Estimable function of degree r, Kernel, symmetric Kernel, U- statistic, variance of U- Statistic, one sample U-Statistic theorem, Hollander and Proschan Test, Test for exponetiality against positive ageing based n sample spacing, Analytical test for exponentiality against NBUE, Deshpande's Test, Two sample U- statistic theorem, Wilcoxon and Mann –Whitney test, Gehan's test, Mantel- Haenzel test, Log rank test, Semi-parametric regression for failure rate - Cox's proportional hazards model with one and several covariates. Competing risk models, Repair models, Probabilistic models, Joint distribution of failure times, Unconditional tests for the time truncated case. **(15L)**

References:

1) Cox, D.R. and Oakes, D. (1984) Analysis of Survival Data, Chapman and Hall, New York.
2) Deshpande ,J.V, Purohit, S. G.,(2005), Life Time Data :Statistical Models and Methods
3) Elandt - Johnson, R.E., Johnson N.L. (1980) Survival models and Data Analysis, John Wiley and Sons
4) Gross A.J. and Clark, V. A. (1975) Survival Distributions: Reliability Applications in the Biomedical Sciences, John Wiley and Sons.
5) Miller, R.G. (1981) Survival Analysis (Wiley)
6) David G. Kleinbaum and Mitchel Klein, (2020) Survival Analysis A Self ‐ Learning Text, Third Edition, (Springer)

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3		3	1	1	1	1	3
CO2	3	3		3	1	1	1	1	3
CO3	3	3		3	1	1	1	1	3
CO4	3	3		3	1	1	1	1	3
CO5	3	3		3	1	1	1	1	3
CO6	3	3		3	1	1	1	1	3
CO7	3	3	2	3	1	1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Identify applications with time to event outcomes. (Weightage: 3 - Strongly Related)

Justification: Identifying applications with time-to-event outcomes is a fundamental aspect of building disciplinary knowledge in survival analysis.

CO2. Construct a life table using the actuarial approach. (Weightage: 3 - Strongly Related)

Justification: Constructing a life table using the actuarial approach is directly related to disciplinary knowledge in survival analysis.

CO3. Construct a life table using the Kaplan-Meier approach. (Weightage: 3 - Strongly Related)

Justification: Constructing a life table using the Kaplan-Meier approach is a key aspect of disciplinary knowledge in survival analysis.

CO4. Perform and interpret the log-rank test. (Weightage: 3 - Strongly Related)

Justification: Performing and interpreting the log-rank test is crucial for disciplinary knowledge in survival analysis and hypothesis testing.

CO5. Compute and interpret a hazard ratio. (Weightage: 3 - Strongly Related)

Justification: Computing and interpreting hazard ratios is a core concept in survival analysis, contributing directly to disciplinary knowledge.

CO6. Interpret coefficients in Cox proportional hazards regression analysis. (Weightage: 3 - Strongly Related)

Justification: Interpreting coefficients in Cox proportional hazards regression analysis is essential for disciplinary knowledge in survival analysis.

CO7. Learn about censored and truncated data and understand how to handle these issues in survival analysis. (Weightage: 3 - Strongly Related)

Justification: Understanding and handling censored and truncated data is a critical aspect of disciplinary knowledge in survival analysis.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from identifying applications to interpreting complex statistical analyses in survival analysis.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and focused on survival analysis methodologies, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of survival analysis.

PO5. Trans-disciplinary Knowledge

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on survival analysis methodologies within a specific discipline than on trans-disciplinary aspects.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in survival analysis, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on survival analysis methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Survival analysis is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(A)
Paper : IV Title of Paper : Actuarial Statistics
Credit : 4 credits No. of lectures: 60

A) Course objectives:

1. The main objective of this course is to learn and understand various concepts involved in Actuarial Statistics.
2. Students should be able to describe, explain and apply the fundamental theories of actuarial statistics as they apply in life insurance, endowment insurance, n-year term life insurance.
3. Students should be able to apply appropriate modeling techniques for lifetime random variables involved in the field of Insurance.

B) Course outcomes:

By the end of the course, students should be able to:

CO1. identify and analyse consequences of events involving risk and uncertainty.
CO2. calculate survival function, curtate future lifetime, force of mortality.
CO3. calculate various payments from life tables using principle of equivalence, net premiums, prospective and retrospective reserve.
CO4. understand the principles of risk management and how they apply to actuarial practice.
CO5. gain insights into the insurance and financial industries, including current trends, challenges, and opportunities.
CO6. apply actuarial techniques to real-world scenarios and case studies.
CO7. explore ethical considerations and responsibilities in the actuarial profession.

TOPICS/CONTENTS:

Unit- 1

Introduction to Insurance Business, insurance and utility theory, time-until-death random variable, survival function, distribution function, density functions and force of mortality and curtate-future lifetime random variable its probability mass function, deferred probabilities, all these functions in terms of international actuarial notation. Analytical laws of mortality such as Gompertz' law and Makeham's law, select and ultimate life table. **(15L)**

Unit -2

Principles of compound interest: Nominal and effective rates of interest and force of interest and discount, compound interest, accumulation factor, continuous compounding. Life insurance: Insurance payable at the moment of death and at the end of the year of death, level benefit insurance, whole life insurance, endowment insurance, deferred insurance and varying benefit insurance, recursion equation, Actuarial present value of the benefit. net single premiums. **(15L)**

Unit- 3

Annuity contracts, annuity certain, discrete annuity, m-thly annuity, continuous annuity, deferred annuity, present values and accumulated values of these annuities. Continuous life annuity, discrete life annuity such as whole life annuity, temporary life annuity, n-year certain and life annuity, life annuities with m-thly payments. Present value random variables for these annuity payments, their means and variances, Actuarial present value of the annuity. **(15L)**

Unit -4

Loss at issue random variable, various principles to decide net premiums for insurance products and annuity schemes defined in unit II and III, fully continuous premiums and fully discrete premiums, true m-thly payment premiums, extended equivalence principle to decide gross premiums, concept of reserve, prospective and retrospective reserve, fully continuous reserve, fully discrete reserve. **(15L)**

References:

1. Bowers, JR. N.L., Gerber, H.U., Hickman, J.C., Jones, D.A. and Nesbitt, C.J. (1997). Actuarial Mathematics, 2nd Edn, the Society of Actuaries.
2. Deshmukh S.R. (2009). Actuarial Statistics: An Introduction Using R, Universities Press.
3. Actuarial Mathematics, Society of Actuaries,ltasca,lllinois,U.S.A.2nd Ed.(1997)
4. Spurgeon E.T. (1972); Life Contingencies, Cambridge University Press. Neill, A. Life Contingencies, Heinemann.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3		1		1	3
CO2	3	3		3		1		1	3
CO3	3	3		3		1		1	3
CO4	3	3		3		1		1	3
CO5	3	3		3	2	1		1	3
CO6	3	3		3		1		1	3
CO7	3	3	3	3		1	3	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Identify and analyze consequences of events involving risk and uncertainty. (Weightage: 3 - Strongly Related)

Justification: Identifying and analyzing consequences of events involving risk and uncertainty is foundational to building disciplinary knowledge in actuarial science.

CO2. Calculate survival function, curtate future lifetime, force of mortality. (Weightage: 3 - Strongly Related)

Justification: Calculating survival functions, future lifetime, and force of mortality directly contributes to disciplinary knowledge in actuarial science.

CO3. Calculate various payments from life tables using the principle of equivalence, net premiums, prospective and retrospective reserves. (Weightage: 3 - Strongly Related)

Justification: Calculating various payments from life tables is a core aspect of disciplinary knowledge in actuarial science, involving financial calculations.

CO4. Understand the principles of risk management and how they apply to actuarial practice. (Weightage: 3 - Strongly Related)

Justification: Understanding risk management principles is crucial for building disciplinary knowledge in actuarial science.

CO5. Gain insights into the insurance and financial industries, including current trends, challenges, and opportunities. (Weightage: 3 - Strongly Related)

Justification: Gaining insights into industries and understanding trends, challenges, and opportunities contributes directly to disciplinary knowledge in actuarial science.

CO6. Apply actuarial techniques to real-world scenarios and case studies. (Weightage: 3 - Strongly Related)

Justification: Applying actuarial techniques to real-world scenarios is an essential component of disciplinary knowledge in actuarial science.

CO7. Explore ethical considerations and responsibilities in the actuarial profession. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical considerations is integral to disciplinary knowledge in actuarial science, emphasizing professional conduct and responsibility.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from identifying consequences of events to applying actuarial techniques in real-world scenarios.

PO3. Social Competence

CO7. Explore ethical considerations and responsibilities in the actuarial profession. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical considerations has a strong social dimension, making this outcome highly related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of actuarial science.

PO5. Trans-disciplinary Knowledge

CO5. Gain insights into the insurance and financial industries, including current trends, challenges, and opportunities. (Weightage: 2 - Moderately Related)

Justification: Gaining insights into industries has trans-disciplinary aspects, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in actuarial science, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

CO7. Explore ethical considerations and responsibilities in the actuarial profession. (Weightage: 3 - Strongly Related)

Justification: Exploring ethical considerations is strongly related to effective citizenship and ethical conduct in the actuarial profession.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on actuarial methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Actuarial science is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(B)

Paper : IV Title of Paper : Reliability Theory

Credit : 4 credits No. of lectures : 60

A) Course Objectives:

1. This course covers the main statistical methods used in reliability and life data analysis. The main distributions used in reliability data analysis are overviewed.
2. The aging properties of different distributions are explored.
3. To introduce students to the theory and practice of reliable system design and evaluation.
4. A course in reliability helps in probabilistic modeling of the reliability of systems with multiple components and statistical modeling of reliability of individual components based on lifetime data.

B) Course Outcomes:

By the end of the course, students should be able to:

CO1. The students will be able to evaluate system reliability for series, parallel, k out of n systems.

CO2. The students will be able to get idea of important lifetime distributions such as for exponential, Weibull, gamma and lognormal distributions.

CO3. Learn and compute various reliability metrics, including reliability function, failure rate, mean time to failure (MTTF), and mean time between failures (MTBF).

CO4. develop skills in evaluating the overall reliability of complex systems.

CO5. learn to represent and analyze system reliability using reliability block diagrams, and understand the concept of redundancy in improving system reliability.

CO6. understand how to integrate component reliability information into a system reliability assessment.

CO7. develop skills in effectively communicating reliability analysis results, and prepare reports and presentations for diverse stakeholders.

TOPICS/CONTENTS:

Unit-1

System of components, coherent structures, representation of coherent systems in terms of paths and cuts, modules of coherent systems, modules of coherent system, **(15 L)**

Unit- 2

Reliability of system of independent components, association of random variables, bounds on system reliability, improved bounds on system reliability using modular decompositions, shape of the system reliability function, applications to relay circuits and safety monitoring systems. **(15L)**

Unit- 3

Notion of aging, exponential distributions, Poisson distribution, parametric families of life distributions with monotone failure rate, **(10 L)**

Unit- 4

Life distributions of coherent systems, distributions with increasing failure rate average arising from shock models, preservation of life distribution classes under reliability operations. Reliability bounds, mean life series and parallel systems, classes of life distributions applicable in replacement models, Shock models, age replacement and block replacement policies, renewal theory useful in replacement models, replacement policy comparisons, preservation of life distribution classes under reliability operations. **(20 L)**

References:

1) Barlow R.E. and Proschan F. (1985): Statistical Theory of Reliability and Life Testing; Holt, Rinehart and Winston.
2) Barlow, R. E. and Proschan, F. (1996). Mathematical Theory of Reliability. John Wiley.
3) Lawless J.F. (2003): Statistical Models and Methods of Life Time Data, 2nd Edition, John Wiley. 3. Shaked M. and Shanthikumar G. (2010): Stochastic Orders, Springer.
4) Nelson, W.B. (2004): Applied Life Data Analysis, Wiley-Blackwell.
5) Zacks, S. (2011): Introduction to Reliability Analysis - Probability Models and Statistical Methods, Springer.
6) Tobias, P. A. and Trindane, D. C. (1995). Applied Reliability, Second edition. CRC Press.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3	1	1	1	1	3
CO2	3	3		3	1	1	1	1	3
CO3	3	3		3	1	1	1	1	3
CO4	3	3		3	1	1	1	1	3
CO5	3	3		3	1	1	1	1	3
CO6	3	3		3	1	1	1	1	3
CO7	3	3	2	3	1	1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Evaluate system reliability for series, parallel, k out of n systems. (Weightage: 3 - Strongly Related)

Justification: Evaluating system reliability for different configurations is fundamental to building disciplinary knowledge in reliability engineering.

CO2. Get an idea of important lifetime distributions such as for exponential, Weibull, gamma, and lognormal distributions. (Weightage: 3 - Strongly Related)

Justification: Understanding important lifetime distributions is crucial for building disciplinary knowledge in reliability engineering.

CO3. Learn and compute various reliability metrics, including reliability function, failure rate, mean time to failure (MTTF), and mean time between failures (MTBF). (Weightage: 3 - Strongly Related)

Justification: Learning and computing various reliability metrics directly contributes to disciplinary knowledge in reliability engineering.

CO4. Develop skills in evaluating the overall reliability of complex systems. (Weightage: 3 - Strongly Related)

Justification: Developing skills in evaluating overall reliability is an integral part of disciplinary knowledge in reliability engineering.

CO5. Learn to represent and analyze system reliability using reliability block diagrams, and understand the concept of redundancy in improving system reliability. (Weightage: 3 - Strongly Related)

Justification: Understanding and representing system reliability using diagrams and the concept of redundancy align with disciplinary knowledge in reliability engineering.

CO6. Understand how to integrate component reliability information into a system reliability assessment. (Weightage: 3 - Strongly Related)

Justification: Integrating component reliability information into system assessments is a key aspect of disciplinary knowledge in reliability engineering.

CO7. Develop skills in effectively communicating reliability analysis results, and prepare reports and presentations for diverse stakeholders. (Weightage: 3 - Strongly Related)

Justification: Developing communication skills for reliability analysis results is crucial for disciplinary knowledge in reliability engineering, ensuring effective stakeholder engagement.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from evaluating system reliability to developing communication skills for presenting results.

PO3. Social Competence

CO7. Develop skills in effectively communicating reliability analysis results, and prepare reports and presentations for diverse stakeholders. (Weightage: 2 - Moderately Related)

Justification: Developing communication skills for diverse stakeholders has a social dimension, making this outcome moderately related to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of reliability engineering.

PO5. Trans-disciplinary Knowledge

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on reliability engineering methodologies within a specific discipline than on trans-disciplinary aspects.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in reliability engineering, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on reliability engineering methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Reliability engineering is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS
(2019 Pattern)
(With effect from Academic Year 2020-2021)

Paper Code : STAT-5404(C)

Paper : IV Title of Paper : Statistical Analysis of Micro-Array Data

Credit : 4 credits No. of lectures : 60

A) Course objectives:

1) This course concentrates on basic introduction to DNA microarray technology, the underlying biology and the technologies for measuring RNA levels and present statistical methods for handling the complex data produced by experiments using the technology.

2) The course seeks to provide instructions to analyze, interpret, design and endorse the use of statistical tools used to analyze high dimensional microarray data.

3) The structure will correspond to the analytical protocol an investigator might follow when working with microarray data.

B) Course outcomes:

Students should be able to:

CO1. understand the principles of microarray technology and its application in genomics.

CO2. recognize the types of microarray platforms and their differences.

CO3. apply exploratory data analysis techniques to understand the characteristics of microarray datasets. Also, visualize gene expression patterns and identify outliers.

CO4. learn about the challenges of multiple hypothesis testing in microarray experiments.

CO5. indulge the facts and elements of applications of genomic and proteomics technologies, and functioning.

CO6. apply statistical techniques to analyze differential gene expression pattern and interpret the results generated.

CO7. recognize modern statistical methods and software to solve complex problems in genome data.

TOPICS/CONTENTS:

Unit- 1

Background of Microarrays and Normalization techniques-

1.1 Introduction and genome project.

1.2 Biology related to microarray experiment- Small molecules, Proteins, DNA, RNA, Transcription, Splicing, Translation.

1.3 Microarray experimental set up and Microarray data- Stages of microarray experiment, Quantification of spotted cDNA (oligonucleotide array) and Quantification of printed in-situ oligonucleotide array.

1.4 Normalization of Microarray Data- Background, Preprocessing of Microarray data, normalization for single channel experiment (mean, median, Q3 and quantile), normalization for two channel experiment (linear or global normalization, linear regression method), Spline and LOWESS (MA plot) normalization, Location-based and Combination of location & intensity-based normalization.

1.5 Concordance coefficient and its role in normalization, Stage wise normalization.

(12T+3Lab)

Unit- 2

Statistical Inference procedures in comparative experiments-

2.1 Introduction to statistical Inference- Estimation of parameters, Testing of Hypothesis, types of errors, large sample test, Small sample test, paired test, shapiro Wilk Normality test, wilcoxon signed rank test, F-test, One-way ANOVA F-test, Non-parametric Kruskal- Wallis test, Welch test, ANOVA Welch F-test.

2.2 Inference procedures for single channel and two channel microarray data- Application of two sample t – test, Tests for validating assumptions of two sample t-test, Application of Welch test and Wilcoxon rank sum test, Application of two sample inference procedures to microarray data.

2.3 Inference procedures for comparing more than two types of mRNA samples (single channel & two channel)- Application of one-way ANOVA F test, one-way ANOVA Welch F test, Kruskal-Wallis Test, pairwise t-test, pairwise Welch test and pairwise Wilcoxon rank sum test.

2.4 Strip charts and its role to decide the profile of differentially expressed genes.

(12T+3Lab)

Unit- 3

Multiple Hypothesis Testing Problem and Principal component analysis-

3.1 Multiple Hypothesis Testing Problem- False positive and false negative, Per comparison error rate (PCER), Family WiseError Rate (FWER), adjusted p-values, Bonferroni Adjustment, Sidak Adjustment.

3.2 False discovery rate (FDR) and its properties and its application to microarray data analysis.

3.3 Principal Component Analysis- Introduction to Principal component analysis, scree plot, Score plot to display sets of differentially expressed genes, Biplot.

3.4 Its application to microarray data analysis. **(12T+3 Lab)**

Unit- 4

Cluster Analysis and Logistic Regression-

4.1 Cluster Analysis- Hierarchical methods of cluster analysis, Ward's method, Non-Hierarchical method of microarray data to identify groups of genes and outlying genes and its application.

4.2 Logistic Regression- Logistic regression model, saturated model, model selection criteria AIC and BIC, application of logistic regression for microarray data.

(12T+3 Lab)

Note: R software will be heavily used in applications of all the statistical methods to microarray data to identify differentially expressed genes in two or more biological samples.

References:

1) Amartunga D. and Cabrera J. (2004). Exploration and Analysis of DNA Microarray and Protein Array Data. Wiley.
2) Deshmukh S.R. (2007). Microarray Data: Statistical Analysis Using R, Narosa.
3) Draghici, S. (2003). Data Analysis Tools for DNA Microarrays, Chapman and Hall/CRC.
4) Dov, S. (2003). Microarray Bioinformatics, Cambridge University Press,
5) McLachlan, G.J.; Do, K.A. and Ambroise, C. (2004). Analyzing Microarray Gene Expression Data, Wiley.
6) Simon, R.M. ; Korn, E.L. ; McShane, L.M. ; Radmacher, M.D. ; Wright, G.W. and Zhao, Y. (2003). Design and Analysis of DNA Microarray Investigations. Springer.
7) Speed, T. (2003). Statistical Analysis of Gene Expression Microarray Data, Chapman and Hall/CRC.

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3		3	1	1	1	1	3
CO2	3	3		3	1	1	1	1	3
CO3	3	3		3	1	1	1	1	3
CO4	3	3		3	1	1	1	1	3
CO5	3	3		3	1	1	1	1	3
CO6	3	3		3	1	1	1	1	3
CO7	3	3	2	3	1	1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the principles of microarray technology and its application in genomics. (Weightage: 3 - Strongly Related)

Justification: Understanding the principles of microarray technology directly contributes to building disciplinary knowledge in genomics.

CO2. Recognize the types of microarray platforms and their differences. (Weightage: 3 - Strongly Related)

Justification: Recognizing microarray platforms and their differences is integral to disciplinary knowledge in genomics, providing insights into available technologies.

CO3. Apply exploratory data analysis techniques to understand the characteristics of microarray datasets. Also, visualize gene expression patterns and identify outliers. (Weightage: 3 - Strongly Related)

Justification: Applying data analysis techniques to microarray datasets is a fundamental aspect of disciplinary knowledge in genomics.

CO4. Learn about the challenges of multiple hypothesis testing in microarray experiments. (Weightage: 3 - Strongly Related)

Justification: Learning about the challenges of multiple hypothesis testing is crucial for disciplinary knowledge in genomics, addressing statistical complexities.

CO5. Indulge in the facts and elements of applications of genomic and proteomics technologies, and functioning. (Weightage: 3 - Strongly Related)

Justification: Engaging with the applications of genomic and proteomics technologies contributes directly to disciplinary knowledge in genomics.

CO6. Apply statistical techniques to analyze differential gene expression patterns and interpret the results generated. (Weightage: 3 - Strongly Related)

Justification: Applying statistical techniques to analyze gene expression patterns is a core aspect of disciplinary knowledge in genomics.

CO7. Recognize modern statistical methods and software to solve complex problems in genome data. (Weightage: 3 - Strongly Related)

Justification: Recognizing modern statistical methods and software for genome data is crucial for disciplinary knowledge in genomics.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from understanding microarray principles to applying statistical techniques for data analysis.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and focused on genomics methodologies, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of genomics.

PO5. Trans-disciplinary Knowledge

CO5. Indulge in the facts and elements of applications of genomic and proteomics technologies, and functioning. (Weightage: 2 - Moderately Related)

Justification: Indulging in the applications of genomic and proteomics technologies has trans-disciplinary aspects, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in genomics, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on genomics methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Genomics is a dynamic field, and mastering its principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5405

Paper : V Title of Paper : Practical-VII

Credit : 4 credits

A) Course Objectives:

1. To introduce students to Markov processes, including discrete-time and continuous-time Markov chains, and to enable them to analyze and model real-world problems using these processes.
2. Students will learn the fundamental properties of stochastic processes, including stationarity, ergodicity, and Markovian properties.
3. Students will learn techniques for analyzing the behavior of stochastic processes, including mean, variance, and higher-order moments.
4. Students will learn concepts of SPC, including control charts, process variation, common cause variation, and special cause variation.
5. Students will learn to analyze and evaluate various types of risks in insurance and financial settings.
6. Students should gain a strong understanding of the fundamental principles of actuarial science, including concepts such as risk, probability, and statistical analysis.
7. Students will Learn how to create parametric models using mathematical equations or statistical methods.

B) Course Outcomes:

Students should be able to:

CO1. Understand the applications of stochastic processes in modeling real-world phenomena.

CO2. Learn the fundamentals of stochastic calculus, including Ito's lemma and stochastic differential equations (SDEs).

CO3. Analyze and model various types of stochastic processes, including Poisson processes.

CO4. Understanding the principles and techniques of SPC to monitor, control, and improve processes.

CO5. Proficiency in using statistical tools and charts to analyse process variation and make data- driven decisions for quality improvement.

CO6. Acquire knowledge of actuarial mathematics, including probability theory and mathematical modelling.

CO7. Learn about various actuarial models and techniques for risk assessment and management.

Sr. No.	Title of Experiments
1.	Realization of Markov chain and calculation of n-step transition probabilities and limiting distribution in Markov chain.
2.	Realization of Poisson process.
3.	Realization of birth and death process.
4.	CUSUM and EWMA charts.
5.	Process capability analysis for normal data.
6.	Synthetic chart for mean and Multivariate control chart.
7.	Non parametric control chart
8.	Parametric analysis of complete data.
9.	Parametric analysis of censored data.
10.	Computation of Actuarial estimator of survival function and PL –Estimator.
11.	Practical based on test for exponentiality- I
12.	Practical based on test for exponentiality - II
13.	Field Visit/ Industrial Visit/ Study Tour (2 Practicals)

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1	3	3	1	3		1	1	1	3
CO2		3	1	3		1	1	1	3
CO3		3	1	3		1	1	1	3
CO4		3	1	3		1	1	1	3
CO5		3	1	3		1	1	1	3
CO6		3	1	3	2	1	1	1	3
CO7		3	1	3		1	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Understand the applications of stochastic processes in modeling real-world phenomena. (Weightage: 3 - Strongly Related)

Justification: Understanding applications of stochastic processes directly contributes to building disciplinary knowledge in the field.

PO2. Critical Thinking and Problem Solving

All COs (Weightage: 3 - Strongly Related)

Justification: All outcomes involve critical thinking and problem-solving skills, from understanding stochastic processes to applying statistical tools for analysis.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more technical and focused on stochastic processes, with less direct relevance to social competence.

PO4. Research-related Skills and Scientific Temper

All COs (Weightage: 3 - Strongly Related)

Justification: The outcomes align closely with research-related skills and the development of a scientific temper in the context of stochastic processes.

PO5. Trans-disciplinary Knowledge

CO6. Acquire knowledge of actuarial mathematics, including probability theory and mathematical modeling. (Weightage: 2 - Moderately Related)

Justification: Acquiring knowledge of actuarial mathematics involves trans-disciplinary aspects, making this outcome moderately related.

PO6. Personal and Professional Competence

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes contribute more to technical competence in stochastic processes and actuarial mathematics, with limited direct connections to personal and professional aspects.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical and less directly related to citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on stochastic processes and actuarial methodologies than on environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: Stochastic processes and actuarial mathematics are dynamic fields, and mastering their principles requires ongoing self-directed learning and adaptation.

SYLLABUS (CBCS) FOR M.Sc.-II Sem.-IV STATISTICS

(2019 Pattern)

(With effect from Academic Year 2020-2021)

Paper Code : STAT-5406

Paper : VI Title of Paper : Project

Credit : 4 credits

A) Learning Objectives:

The main objective of this course is to

5. develop proficiency in using statistical software packages like R, SPSS, Matlab or Python for data analysis and visualization.
6. acquire skills in data collection, data cleaning, and data transformation.
7. improve the ability to communicate statistical findings effectively through written reports and presentations
8. apply advanced statistical techniques to analyze the research data and draw meaningful conclusions
9. interpret the results of the analysis and discuss their implications in the context of the project questions/objectives.
10. present the project findings in a clear and concise manner, both in written form and through oral presentations.
11. develop the ability to critically evaluate existing statistical literature and research studies in the field.

B) Course Outcomes:

CO1. Students will be able to gain practical experience in data collection, data cleaning, and data imputation, which are essential skills in statistics, data analytics and data science.

CO2. Gaining expertise in statistical software packages like R, SAS, or Python and using these tools is valuable for future career opportunities in IT industry and many more filed.

CO3. MSc project serves as a valuable stepping stone, demonstrating research capabilities.

CO4. Statistical analysis may provide insights that can inform policy or decision-making in these areas in a specific social issue or problem, such as healthcare, education, or environmental sustainability.

CO5. MSc projects can identify actionable insights; consider providing recommendations or guidelines for addressing the social issue that were studied.

CO6. Collaborate with experts from other fields (e.g., biology, economics, psychology, garniture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights.

CO7. Successful MSc projects can open doors to consulting opportunities where students can apply statistical methods to solve practical problems for businesses or organizations.

This part of the course consist summary of research articles, data analysis and report in dissertation form.

1. **Summary of Research Articles**

Students are expected to choose her/his own project topic and read some (not less than 2) articles (exact number of articles will be decided by the supervisor) on a selected topic or theme, summarize and write a comprehensive report and present the summary of the articles.

2. **Data Analysis**

Students are expected to analyze data pertaining to certain theme using a variety of statistical tools that they have studied so far.

Note:

1. Students have to prepare project report and have to submit one copy for the assessment.

2. Data analysis project can be done in a group (at the most 3 students).

Programme Outcomes and Course Outcomes Mapping:

Course Outcomes	Programme Outcomes (POs)								
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CO1	3		1				1	1	3
CO2		3	1				1	1	3
CO3			1	3			1	1	3
CO4			1	3			1	1	3
CO5			1	3			1	1	3
CO6			1		3		1	1	3
CO7			1			2	1	1	3

Weight: 1 - Partially related 2 - Moderately Related 3 - Strongly related

PO1. Disciplinary Knowledge

CO1. Students will be able to gain practical experience in data collection, data cleaning, and data imputation, which are essential skills in statistics, data analytics, and data science. (Weightage: 3 - Strongly Related)

Justification: Gaining practical experience in data-related tasks directly contributes to building disciplinary knowledge in statistics, data analytics, and data science.

PO2. Critical Thinking and Problem Solving

CO2. Gaining expertise in statistical software packages like R, SAS, or Python and using these tools is valuable for future career opportunities in IT industry and many more fields. (Weightage: 3 - Strongly Related)

Justification: Gaining expertise in statistical software involves critical thinking and problem-solving skills, aligning with the critical thinking outcome.

PO3. Social Competence

All COs (Weightage: 1 - Partially Related)

Justification: While aspects of the MSc project and collaboration may involve social competence, the overall focus is more technical.

PO4. Research-related Skills and Scientific Temper

CO3. MSc project serves as a valuable stepping stone, demonstrating research capabilities. (Weightage: 3 - Strongly Related)

CO4. Statistical analysis may provide insights that can inform policy or decision-making in these areas in a specific social issue or problem, such as healthcare, education, or environmental sustainability. (Weightage: 3 - Strongly Related)

CO5. MSc projects can identify actionable insights; consider providing recommendations or guidelines for addressing the social issue that were studied. (Weightage: 3 - Strongly Related)

Justification: The MSc project and statistical analysis directly contribute to research-related skills and the development of a scientific temper.

PO5. Trans-disciplinary Knowledge

CO6. Collaborate with experts from other fields (e.g., biology, economics, psychology, garniture, manufacturing industry) to apply statistical methods to interdisciplinary problems, potentially leading to innovative solutions and insights. (Weightage: 3 - Strongly Related)

Justification: Collaboration with experts from other fields aligns with trans-disciplinary knowledge.

PO6. Personal and Professional Competence

CO7. Successful MSc projects can open doors to consulting opportunities where students can apply statistical methods to solve practical problems for businesses or organizations. (Weightage: 2 - Moderately Related)

Justification: While successful MSc projects contribute to personal and professional competence, the emphasis on consulting opportunities makes this outcome moderately related.

PO7. Effective Citizenship and Ethics

All COs (Weightage: 1 - Partially Related)

Justification: The content is more technical, with less direct emphasis on effective citizenship and ethics.

PO8. Environment and Sustainability

All COs (Weightage: 1 - Partially Related)

Justification: The outcomes are more focused on statistical skills and applications, with less direct relevance to environmental or sustainability aspects.

PO9. Self-directed and Life-long Learning

All COs (Weightage: 3 - Strongly Related)

Justification: The ongoing nature of gaining expertise, engaging in MSc projects, and collaborating with experts aligns well with self-directed and life-long learning.