Department of Statistics, University of Jammu

Course Structure and Scheme of Examinations for PG Programme in Statistics- One Year (NEP 2020)

Programme code – PGFMS005

Semester–II

Course Code	Course Title	Credit Hours	Contact Hours per week L-Tu-P
P1STTC201	Stochastic Processes	04	4-1-0
P1STTC202	Optimization Techniques for Decision Making	04	4-1-0
P1STRC203	Research	16	0-0-16
	Total Credits	24	

Syllabus for One Year PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-2 examinations to be held in May-2027,2028 and 2029

Course No: P1STTC201
Credit Hours:04
Duration of examination: 3 hours

Title: Stochastic Processes
Maximum Marks: 100
Minor Test-I : 20
Minor Test-II :20
Major Test : 60

Course Outcomes

- **CO1**: Understand fundamental concepts of stochastic processes, including classification, Markov chains, transition probabilities, and applications such as random walks and gambler's ruin problems.
- **CO2**: Analyse continuous-time Markov processes, Poisson processes, and Brownian motion, applying them to real-world scenarios such as queues and storage systems.
- **CO3**: Explore renewal processes, stationary processes, and time-series models, including moving average and autoregressive methods, for predictive analysis.
- **CO4**: Examine branching processes, extinction probabilities, and martingale properties to model population dynamics and evolutionary behaviour.
- **CO5**: Apply key stochastic modelling techniques for statistical analysis and decision-making in diverse fields, including finance, engineering, and biological sciences.

Unit-I

Introduction to stochastic processes (SP's), Classification of SP's according to state space and time domain, Countable state Markov Chains (MC's), Chapman-Kolmogorov equations; solidarity theorem, calculation of n- step transition probability and its limit, Stationary distribution, Classification of states; transient MC,Random Walk and gambler's ruin problem.

Unit-II

Discrete state space continuous time MC's, Kolomogorav-Feller differential equations, Poisson Process and its properties, Birth and Death processes, Non-homogeneous Poisson Process, Cluster Poisson Process Applications to queues and storage problems, Brownian motion process, Black Scholes formula, Wiener process as a limit of random walk, first passage time and otherproblems.

Unit-III

Renewal process, Modified Renewal Process, Equilibrium Renewal Process; Elementary renewal theorem and applications, CLT for renewal process, statement and uses of key renewal theorem, study of residual and excess lifetimes lifetime process, stationary process, weakly stationary and strongly stationary process, white-noise process, Moving average process, Auto-regressive Processes.

Unit-IV

Galton-Watson branching process, probability of ultimate extinction, distributionof populations size, Martingale and its properties.

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Title: Stochastic Processes
Maximum Marks: 100
Minor Test-I : 20
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Major Test : 60

Books Recommended:

1.	Basu, A.K. (2007)	Introduction to Stochastic Process, Alpha Science International Ltd.
2.	Bhat, B.R. (2020)	Stochastic Models: Analysis And Applications, New Age International Pvt. Ltd.
3.	Ciprian Tudor (2023)	Non-Gaussian Self Similar Stochastic Processes, Springer
4.	Dharmaraja, S., Arunachalam, V. & Castaneda, L.B. (2012)	Introduction to Probability and Stochastic Processes with Applications, Wiley
5.	Feller, W. (1968)	An Introduction to Probability Theory and ItsApplications, John Wiley
6.	Karlin, S. & Taylor H.M. (1975)	A First Course in Stochastic Process, Vol. I Academic Press
7.	Maksym Luz, Mikhail Moklyachuk (2024)	Non-Stationary Stochastic Processes Estimation, De Gruyter
8.	Medhi, J. (2019)	Stochastic Processes, New Age International Pvt. Ltd.
9.	Papoulis, A. & Pillai, S.U. (2008)	Probability, Random Variables, and StochasticProcesses, Tata Mcgraw Hill
10.	Parzen, E. (1999)	Stochastic Processes, Siam
11.	Ross, S. M. (1996)	Stochastic Process, John Wiley & Sons
12.	Ross, S.M. (2009)	Introduction to Probability Models, Academic Press

SCHEME OF EXAMINATION

	Syllabus to be covered in the examination	**Time allotted for the examination**	**%Weightage (Marks)**
MINOR TEST I (after 30 days)	25%	1 hour	20
MINOR TEST II (after 60days)	26 to 50%	1 hour	20
Major Test (after 90 days)	100%	3 hours	60
Total			100

The student shall be continuously evaluated during the conduct of each course based on his/her performance as follows:

Syllabus for One Year PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-2 examinations to be held in May-2027,2028 and 2029

Course No: P1STTC201
Credit Hours:04
Duration of examination: 3 hours

Title: Stochastic Processes
Maximum Marks: 100
Minor Test-I : 20
Minor Test-II :20
Major Test : 60

Minor Test I and Minor Test II

The Subjective Tests of Minor Test I and Minor Test II would consist of 10 **compulsory MCQ** of one mark each and THREE **subjective type questions** (05 marks each). Students are required to answer any **TWO** questions out of three asked questions. **No preparatory holidays shall be provided for the Test I and Test II.**

Those candidates who have appeared in Minor Test I and II and failed to get the minimum required marks i.e. 14 out of 40 will be eligible to re-appear in the Test I and Test II only once.

Major Test

The Major test will comprise of **two sections,** Section-A and Section-B.

Section-A will have **one compulsory question** comprising of 10 parts (minimum 02 questions from each unit) of 03 marks each. (10*3=30 marks).

Section-B will have 04 questions each of 15 marks to be set from the last two units (02 from each unit). In Section B students are required to attempt 01 question from each unit. (15*2=30 marks) .

In major test there should not be a gap of more than two days in between two tests.

Syllabus for One Year PG Programme in Statistics as per National Education Policy (NEP) 2020 for Semester-2 examinations to be held in May-2027,2028 and 2029

Course No: P1STTC202 **Title: Optimization Techniques for Decision Making**

Credit Hours:04 **Maximum Marks: 100**

Duration of examination: 3 hours

Minor Test-I : 20
Minor Test-II : 20
Major Test : 60

Course Outcomes:

- **CO1**: Understand the formulation of linear programming problems (LPP), convex sets, graphical solutions, and advanced optimization techniques such as genetic algorithms and simulated annealing.
- **CO2**: Apply duality principles in LPP, including fundamental theorems, Markov Decision Processes, and sensitivity analysis for model robustness.
- **CO3**: Solve transportation and assignment problems using methods such as stepping-stone, MODI's method, Hungarian method, and explore AI-driven approaches in routing and optimization.
- **CO4**: Develop expertise in game theory concepts, including minimax strategies, Nash equilibrium, and applications of AI in decision-making models.
- **CO5**: Utilize job sequencing techniques, heuristic methods for large-scale optimization, CPM, PERT, and AI-powered project scheduling for efficient resource allocation and industrial process optimization.

Unit-I

Linear programming problem, formulation of LPP, Convex sets, Concept of Separating and supporting Hyperplanes, Half-space, Convex Polyhedron, Graphical method for solving LPP's,

Theorems: Reduction of FS to BFS, Replacement of a Basis Vector, Improved BFS, Condition of Optimality, Extreme Point and BFS relation.

Simplex method for solving LPP, two phase method (Artificial Variable Technique), Big-M-Method and degeneracy in LPP and its resolution, Genetic algorithms, simulated annealing, and evolutionary strategies for solving complex LP problems.

Unit-II

Duality in LPP, Correspondence between dual and primal, theorems on duality, Fundamental duality theorem, Basic duality theorem, existence theorem, complementarity theorem, Solution of primal from duality, Markov Decision Processes (MDP) in duality

Revised Simplex Method, Formulation of LPP in standard form, Application of computation procedurefor standard form, Sensitivity analysis, AI-driven approaches for model robustness and parameter adjustments.

Unit-III

Transportation problem (TP), formulation of TP, FS, BFS and optimum solution, existence of FS, optimal solution method, Stepping-stone method, Methods for finding BFS, U-V (MODI's) method for finding optimal solution, unbalance transportation problem, assignment problems, fundamental theorems of assignment problems, Hungarian method for assignment problems, Routing problems, Applications of machine learning in vehicle routing.

Theory of games, rectangular games Minimax (Maximin) Criterion and optimal strategy, Minimax-Maximin principle mixed strategy, Games and their solutions through different methods including LPP, Minimax theorem, Nash equilibrium computation, game theory in AI-driven decision-making.

Syllabus for One Year PG Programme in Statistics as per National Education Policy ... for Semester-2 examinations to be held in May-2027,2028 and 2029

Course No: P1STTC202 **Title: Optimization Techniques for Decision Making**

Credit Hours:04 **Maximum Marks: 100**

Duration of examination: 3 hours

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Major Test : 60

Unit-IV

Job sequencing, solutions of sequencing problems, processing n-jobs through two- machines, Johnson's algorithm for n-jobs for 2- machines, processing 2-jobs through n-machines graphical method, processing n-jobs through m-machines, Travelling Salesman Problem. AI-driven heuristic methods for large-scale optimization, genetic algorithms in TSP.
CPM and PERT, Determination of critical path's, applications of CPM,PERT, AI-driven project scheduling and resource allocation, Neural network-based scheduling, predictive modeling in industrial process optimization, AI-powered decision support systems, automated scheduling solutions, and predictive analytics for supply chain optimization.

Books Recommended:

1.	El-Ghazali Talbi	*Metaheuristics: From Design to Implementation* (covers genetic algorithms, simulated annealing, and evolutionary strategies)
2.	Harris, C.M. & Gross, D. (2018)	Fundamentals of Queueing Theory, Wiley
3.	Imhade P. Okokpujie, Lagouge K. Tartibu (2023)	Modern Optimization Techniques for Advanced Machining, Springer publisher.
4.	Kanti Swarup, Gupta, P.K. and Manmohan (2014)	Operations Research, Sultan Chand & Sons
5.	Konstantinos Gkoumas (2021)	Machine Learning for Transportation Planning and Traffic Modeling, Springer
6.	Martin L. Puterman (1994)	Markov Decision Processes: Discrete Stochastic Dynamic Programming, Wiley-Interscience
7.	Michael L. Pinedo (2012)	Scheduling: Theory, Algorithms, and Systems, Springer
8.	Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay Vazirani (2007)	Algorithmic Game Theory, Cambridge University Press
9.	Rao, S.S. (1984)	Optimization: Theory and applications, John Wiley
10	Santosh Kumar Das, Massimiliano Giacalone (2023)	Fuzzy Optimization Techniques in the Areas of Science and Management, CRC Press

11	Taha, H.A. (2016)	Operations Research, Pearson Education India
12	Yongsheng Ma (2013)	Neural Networks for Optimization and Scheduling, Springer

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Course No: P1STRC203 **Title: Research**

Credit Hours:16 **Maximum Marks: 400**

Course Outcomes:

Upon successful completion of this 16-credit postgraduate-level research course, students will:

- Develop advanced proficiency in research methodologies, enabling them to design and execute impactful studies.
- Critically evaluate scholarly literature to identify gaps and formulate innovative research questions.
- Master data collection techniques and analytical tools, applying both quantitative and qualitative approaches.
- Demonstrate the ability to independently plan and conduct a comprehensive research project or dissertation.
- Exhibit strong academic writing and oral communication skills to effectively present findings.
- Uphold ethical standards and integrity in all aspects of research and scholarly reporting.
- Contribute novel insights to their field, showcasing originality and rigor in their dissertation work.

Every student shall undertake the research under a departmental teacher who will be designated as Research Supervisor. After completion of research work students will have to produce a report in the form of dissertation/technical report related to the work carried out and duly signed by the research supervisor and Head of the department.

SCHEME OF EXAMINATION

External Research examination shall be conducted by Board of Examiners consisting of Head of the Department, concern teacher and one outside expert to be appointed by the Vice-Chancellor out of the panel to be provided by the Head of the Department who shall evaluate/assess dissertation of the students.

The research work will be assessed on the following components:

Content Quality of Report/Dissertation	Seminar Presentation	Domain Knowledge	Total
150	100	150	400