FYUP Course Outline for Semester VI

S. No.	Course Code	Course Title	Credits	Category
1	MTHS350MJ	Models	4	Major
2	MTHS351MJ	Financial Derivatives	4	Major
3	MTHS352MJ	Demography	4	Major
4	MTHS353MJ	Graph theory	4	Major
5	MTHS354MJ	Financial Management	4	Major
6	DOMS350MV	Insurance	4	Minor Vocational

Note: Students have to choose elective subjects either MTHS352MJ or MTHS353MJ

B.Sc. Mathematical Sciences- FYUGP

Course Title	**:**	Models	***Semester-VI***
Course Code	**:**	MTHS350MJ	
Credit hrs.	**:**	4	

Course Objective: The main objective of this course is to apprise the students about the existence of several stochastic processes in real life situations and to equip them with the techniques to study their statistical behavior as a sequence of dependent random variables.

Course Outcomes: After the completion of paper student will be able to:

1. Understand lifetime models for data analysis
2. Understand several stochastic processes in real life situations.

Unit I: Concept of a stochastic process, classification of a stochastic process according to state space and parameter space, Stationary Processes: Weakly stationary and strongly stationary processes, Discrete-time Markov Chains (DTMCs): Definition and examples of MCs, transition probability matrix, Chapman-Kolmogorov equations; calculation of n-step transition probabilities, limiting probabilities, classification of states, Irreducibility, ergodicity, stationary distribution, transient MC.

Unit II: Markov process, Kolmogorov equations for Markov process, Poisson process, birth and death processes

Unit III: Survival models, sickness and marriage models in terms of Markov processes, force of mortality, hazard rate. Actuarial symbols tp_x and tq_x and integral formulas, Gompertz-Makeham laws of mortality, life tables

Unit IV: Lifetime distributions and estimation, Failure rate, mean residual life and their elementary properties, types of censoring, Estimation of survival function, Kaplan-Meier estimate, Nelson-Aalen estimate and their applications, Semi-parametric regression for failure rate, Cox proportional hazard model

Recommended Textbooks:

- Stochastic Processes by Sheldon Ross
- A First Course in Stochastic Processes by Karlin and Taylor
- An Introduction to Stochastic Modeling by Karlin and Taylor
- Stochastic Processes by J. Medhi
- Stochastic Models: Analysis and Application by B.R. Bhat
- Cox, D.R. and Oakes, D., *Analysis of Survival Data*, Chapman and Hall, New York.

- Gross A.J. and Clark, V. A., *Survival Distributions: Reliability, Applications in the Biomedical Sciences*, John Wiley and Sons.
- Elandt - Johnson, R.E. Johnson N.L., *Survival models and Data Analysis*, John Wiley and Sons
- Miller, R.G., *Survival Analysis* (Wiley)
- Deshpande, J.V. and Purohit S.G., *Life-Time Data: Statistical Models and Methods* , World Scientific Book Publishing
- Actuarial Mathematics, Bowers et al, Society of Actuaries, USA

B.Sc. Mathematical Sciences- FYUGP

Course Title	**:**	Financial Derivatives	***Semester-VI***
Course Code	**:**	MTHS351MJ	
Credit hrs.	**:**	4	

Course Objective: Introduces the students regarding the fundamentals of financial derivatives. The students' will also get overview of stock markets and trading strategies involving options.

Course Outcomes:

1. Understand and evaluate complex dimensions of the financial derivatives.
2. Map statistical concepts and techniques to finance for risk assessment.
3. Understand to Quantify risks.
4. Develop basic financial Decisions.

Unit I: Forward Contracts-Future Contracts-Settlement –Regulation Standardization-Options-Interest Rates and Bond Prices-Zero Coupon Bond Prices-Discretely and continuously compounded interest rates.

Unit II: Asset-Price Dynamics-Lognormal Distribution-The Bi-nominal approximation to the Lognormal Distribution-Stochastic Differential Equation Representation- Complications-Lognormal Distribution, Continuous Trading, Continuously Changing Prices.

Unit III: Binomial Pricing Model- Single Period Example- Multi period Example- Constructing Synthetics Option- Risk Neutral Valuation- Hedge Ratio (Delta), Lattice Parameters- Replicating an option on spot with Future.

Unit IV: Black-Scholes Model, Continuous Time Representative of Stock Price Changes- Ito's Lemma- The Equivalent Martingale Probability Distribution- Hedging-Option Strategies- Partial Differences Equations.

Unit V: SWAPS-Interest Rate Swaps-Pricing, Warehousing, Valuation, Par Swaps, Variants-Foreign Currency Swaps- Valuation- Commodity Swaps- Valuation and Variants- Equity Swaps-Valuation and Variants.

Suggested Reading:

- Bhalla, V.K. Investment Management: Security analysis and Portfolio Management, New Delhi, S. Chand, 2001.
- Brennet, M. Option Pricing: Theory and Applications. Toronto, Lexington Books, 1993.
- Cox John C and Rubinstein, Mark Options Markets, Englewood Cliffs, New Jerxey, Prentice Hall Inc., 1985.
- Huang, Stanley S.C. and Randall, Maury R. Investment Analysis and Management. London, Allyn and Bacon, 1987.

- Hull, John C. Options, Futures and other Derivative Securities. 2nd ed. New Delhi, Prentice Hall of India., 1996.
- Sharpe, William F. et al. Investment, New Delhi, Prentice Hall of India, 1997.

B.Sc. Mathematical Sciences- FYUGP

Course Title	**:**	Demography	***Semester-VI***
Course Code	**:**	MTHS352MJ	
Credit hrs.	**:**	4	

Course Objective: This course provides a comprehensive survey of the field of social demography the scientific study of population. The course begins by focusing on understanding the core social demographic variables (e.g., fertility, mortality, morbidity, migration), and how these variables influence population growth, composition, and structure.

Course Outcomes:

1. Learning about different methods of demographic data collection and related errors.
2. Learning about the fertility/ mortality models.
3. Understanding Life Tables and their construction.
4. Learning about the theory of stable population, population projection and about the concept of migration theory.

UNIT I: Introduction and definition of vital Statistics, coverage and content errors in demographic data, use of balancing equations, Chanderasekharan-Deming formula to check completeness of registration data. Accuracy of age data on sex and age: Whipple's and Myer's indices. Dependency ratio.

UNIT II: Measure of fertility; relationship between CBR, GFR and TFR. Mathematical models on fertility and human reproduction process. Distributions of time to first birth, inter-live birth intervals and of number of births, estimation of parity progression ratios from open birth interval data.

Unit III: Mortality: concepts and rates; measures of infant mortality rate. Force of mortality. Life table and its construction: Complete and abridged. Greville's and Reed-Merrels methods. Relationship between life table functions and their estimation. Relationship between abridged life table functions.

Unit IV: Population projection: Methods for population projection. Use of Leslie matrix. Frejka's component method. Logistic Model for population growth and their fitting to population data. Migration: concepts and rates. Uses of place of birth and duration of residence data.

TEXT BOOKS:

- Bartholomew, D.J. (1982). Stochastic Models for Social Processes, John Wiley.
- Benjamin, B. (1969). Demographic Analysis, George, Allen and Unwin.
- Ching, C. L. (1968). Introduction to Stochastic process in Biostatistics, John Wiley.
- Cox. P. R. (1970). Demography, Cambridge University Press
- Keyfitz, N. (1977). Applied Mathematical Demography, Springer Verlag.
- Spiegelman, M. (1969). Introduction to Demographic Analysis; Harvard University PresS.

B.Sc. Mathematical Sciences- FYUGP

Course Title : Graph Theory ***Semester-VI***
Course Code : MTHS353MJ
Credit hrs. : 4

Course Objectives:

- To introduce students to the fundamental concepts of graph theory.
- To explore the application of graph theory in solving real-world problems.
- To develop Python programming skills for graph modeling, analysis, and visualization.

Course Outcomes: After completing this course, students will be able to:

1. Understand and apply fundamental concepts of graph theory.
2. Solve problems in graph theory computationally using Python.
3. Model real-world scenarios as graphs and analyze them using Python libraries.
4. Develop Python-based projects leveraging graph algorithms and techniques.

Unit 1: Introduction to Graph Theory

- Definitions and Terminologies: Graphs, Vertices, Edges, Degree, Paths and Cycles
- Types of Graphs: Directed, Undirected, Weighted, Bipartite, Complete, Regular, Planar Graphs
- Subgraphs, Connected Components and Graph Representations

Practical:

- Representing of graphs using Python programming.
- Visualizing simple graphs with NetworkX and Matplotlib.

Unit 2: Fundamental Concepts and Properties

- Konig's Berg Bridge Problem
- Eulerian and Hamiltonian Graphs
- Graph Isomorphism
- Applications: Social Networks, Transportation and Communication Networks

Practical:

- Implementing DFS and BFS in Python.
- Checking graph properties such as Eulerian paths and Hamiltonian cycles using Python.

Unit 3: Graph Algorithms

- Trees and its Properties
- Rooted and Binary Trees
- Minimum Spanning Trees: Prim's and Kruskal's Algorithms
- Graph Coloring and applications

Practical:

- Finding minimum spanning trees using NetworkX and custom Python scripts.
- Solving graph coloring problems and visualizing results.

Unit 4: Introduction to Spectral Graph Theory

- Basic Graph Terminology and Matrices (Adjacency Matrix, Degree Matrix and Laplacian Matrix)
- Eigenvalues and Eigenvectors of Graph Matrices
- Python Libraries for Graph Analysis: NetworkX, NumPy and Matplotlib

Practical:

- Introduction to Network X: Creating, visualizing and analyzing graphs.
- Python code for adjacency and Laplacian matrix computation.

Textbooks and References:

1. Reinhard Diestel, *Graph Theory* (Graduate Texts in Mathematics).
2. Narsingh Deo, *Graph Theory with Applications to Engineering and Computer Science*.
3. Bondy and Murty, *Graph Theory and Applications*.
4. Python Libraries Documentation: NetworkX, Matplotlib, NumPy and Pandas.
5. Michael T. Goodrich, *Algorithm Design and Applications*.
6. S. Pirzada, An Introduction to Graph Theory, Universities Press, Bangalore, 2012.
7. V.K. Balakrishnan , Graph Theory Schaum's Outline latest Edition.

B.Sc. Mathematical Sciences- FYUGP

Course Title : Financial Management ***Semester-VI***
Course Code : MTHS354MJ
Credit hrs. : 4

Course Objective: The aim of this course is to provide advance knowledge on financial management like project evaluation, Investment decision, role of financial manager, and how to raise short and long term funds.

Course Outcomes: After the completion of paper student will be able to:

1. Apply various project evaluation techniques to assess the viability and profitability of potential investment projects.
2. Students will gain the ability to make sound investment decisions by analyzing different investment opportunities and aligning them with the organization's strategic goals.
3. Understand the multifaceted role of a financial manager and how it integrates with other organizational functions to achieve overall business objectives.

Unit I: Concept, scope and functions of financial management, relationship with other areas of management. Objectives of financial management, profit and wealth maximization. Organization of finance function. Role of financial Manager. Mathematics of finance. Short and long-term sources of funds, internal financing.

Unit II: Capital structure concepts and theories, net income approach, MM approach, traditional approach. Futures of an adequate capital structure, analysis of capital structure in practice. Over and under capitalization. Capital budgeting, decisions need, importance and processes. Determination of relevant cash flow. Capital budgeting techniques, traditional methods, payback period and accounting rate of return net present value and internal rate of return.

Unit III: Dividend decisions meaning and significance, factors effecting dividend policy, stability of dividends, forms of dividends, legal contractual and internal constraints and restrictions of dividend policy. Irrelevance of dividends, MM hypothesis, relevance of dividend, Walters and Gorden's models.

Unit IV: Concepts and nature of working capital. Determinants of working capital. Estimating working capital needs and its computation. Deciding and appropriate working capital policy. Working capital control and banking policy.

Suggested Readings:

1. Panday I. M. Financial management.
2. Chandra Prasana Financial Management, Theories and Practices.
3. Khan and Jain Financial Management, Text and Problems.

B.Sc. Mathematical Sciences- FYUGP

Course Title	**:**	Insurance	***Semester-VI***
Course Code	**:**	DOMS350MV	
Credit hrs.	**:**	4	

Objective: The main objective is to introduce the basics and concepts of insurance.

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

1. Understand the present status of insurance.
2. Classify in between life and non-life insurance.
3. Know different types of investing and saving schemes in various funds.
4. Recollect the concepts from actuarial science.
5. Understand the function of regulatory bodies like IRDA.

Unit -1: Concept and nature of insurance, purpose and need of insurance, specific principles of insurance, general principles or essentials of insurance contract, miscellaneous principles of insurance. Re-insurance, co-insurance, assignments. Recent developments in insurance.

Unit-2: Concept of risk, types of risk, sources and measurement of risk, risk evaluation and prediction. Risk retention and risk transfer. Pooling in insurance: concept, forms of pooling, costs and benefits of pooling. Introduction to mutual funds and pension funds.

Unit-3: General insurance: Motor, marine, fire, miscellaneous .Life insurance: clauses in life policy, types (whole Life, endowment, annuity, term, joint policy)

Unit-4: Control of mal-practices, negligence, loss assessment and loss control, exclusion of perils, actuaries, computation of insurance premium. Role, power, and functions of IRDA, LIC, and GIC.

Suggested Readings:

- Dinsale, W.A:Elements of Insurance, Pitman.
- Hubner, S.S and Keneth Black: Life Insurance.
- Majumdar, P.I and Diwan, M.G:Principles of Insurance, Insurance of India, Mumbai.
- Sharma,R.s:Insurance: Principles and Practice, Vora Publications, New Delhi.
- George, E. Rejda, Principles of Risk Management and Insurance, Pearson Education.
- Gupta. P.K, Insurance and Risk Management, Himalaya Publishing House.
- Mishra, M. N., Principles and Practices of Insurance, S. Chand and Sons.
- Principles of Insurance: IC-01 Insurance Institute of India.