

**DEPARTMENT OF ACTUARIAL SCIENCE
SCHOOL OF MATHEMATICAL SCIENCES
KAVAYITRI BAHINABAI CHAUDHARI
NORTH MAHARASHTRA UNIVERSITY
JALGAON - 425001, INDIA**



**Syllabus
FOR
Three-year course
B.Sc.(Actuarial Science)
WITH EFFECT FROM ACADEMIC
YEAR 2018-2019
(Course Started from 2010-11)**

**Summary of Distribution of credits for
B.Sc. (Actuarial Science)
at
School of Mathematical Sciences
Under Academic Flexibility at University Campus (w.e.f 2018-19)**

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI
01	Core	22	22	19	19	19	19
02	Campus elective	-	-	-	-	-	-
03	School elective	-	-	-	-	-	-
04	Project	-	-	-	-	-	-
05	Audit	-	-	-	-	-	-
06	Total Credits	22	22	19	19	19	19

Subject Type	Core	Campus Elective	School Elective	Project	Audit	Total
Credits	120	-	-	-	-	120

Total Credits = 120

Department of Actuarial Science
School of Mathematical Sciences
Kavayitri Bahinabai Chaudhari North Maharashtra University, Jalgaon

Syllabus Structure of Three-year course
B.Sc.(Actuarial Science) w.e.f. 2018-19
(The medium of instruction is English)

Semester-I

Course Code	Title of the Course	Contact hours/week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-101	Calculus	04	--	04	40	--	60	--	100	--	04
AS-102	Linear Algebra	04	--	04	40	--	60	--	100	--	04
AS-103	Descriptive Statistics	04	--	04	40	--	60	--	100	--	04
AS-104	Probability Distributions-I	04	--	04	40	--	60	--	100	--	04
AS-105	Practicals- I	--	06	06	--	40	--	60	--	100	03
AS-106	Effective Communication in English	03	--	03	40	--	60	--	100	--	03

Semester-II

Course Code	Title of the Course	Contact hours / week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-201	Mathematical Analysis	04	--	04	40	--	60	--	100	--	04
AS-202	Probability Distributions-II	04	--	04	40	--	60	--	100	--	04
AS-203	Principles of Microeconomics	04	--	04	40	--	60	--	100	--	04
AS-204	Principles and Practices in Insurance	04	--	04	40	--	60	--	100	--	04
AS-205	Practicals-II	--	06	06	--	40	--	60	--	100	03
AS-206	Environment Studies	03	--	03	40	--	60	--	100	--	03

Semester-III

Course Code	Title of the Course	Contact hours / week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-301	Sampling Distributions	04	--	04	40	--	60	--	100	--	04
AS-302	Financial Mathematics	04	--	04	40	--	60	--	100	--	04
AS-303	Principles of Macroeconomics	04	--	04	40	--	60	--	100	--	04
AS-304	R Programming and Numerical Methods	04	--	04	40	--	60	--	100	--	04
AS-305	Practicals-III	--	06	06	--	40	--	60	--	100	03

Semester-IV

Course Code	Title of the Course	Contact hours / week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-401	Mathematical Statistics	04	--	04	40	--	60	--	100	--	04
AS-402	Surveys Sampling & Indian Official Statistics	04	--	04	40	--	60	--	100	--	04
AS-403	Life Contingencies-I	04	--	04	40	--	60	--	100	--	04
AS-404	Financial Accounting	04	--	04	40	--	60	--	100	--	04
AS-405	Practicals-IV	--	06	06	--	40	--	60	--	100	03

Semester-V

Course Code	Title of the Course	Contact hours / week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-501	Survival Models	04	--	04	40	--	60	--	100	--	04
AS-502	Applied Statistics	04	--	04	40	--	60	--	100	--	04
AS-503	Finance and Financial Reporting	04	--	04	40	--	60	--	100	--	04
AS-504	Life Contingencies-II	04	--	04	40	--	60	--	100	--	04
AS-505	Practicals-V	--	06	06	--	40	--	60	--	100	03

Semester-VI

Course Code	Title of the Course	Contact hours / week			Marks Distribution for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-601	Stochastic Modeling	04	--	04	40	--	60	--	100	--	04
AS-602	Total Quality Management and Statistical Process Control	04	--	04	40	--	60	--	100	--	04
AS-603	Credibility Theory & Loss Distributions	04	--	04	40	--	60	--	100	--	04
AS-604	Financial Economics	04	--	04	40	--	60	--	100	--	04
AS-605	Practicals-VI	--	06	06	--	40	--	60	--	100	03

Program at a Glance

B.Sc. (Actuarial Science)

Name of the program	: B.Sc. (Actuarial Science)
Faculty	: Science and Technology
Duration of the Program	: Three years (six semesters)
Medium of Instruction and Examination	: English
Examination Pattern	: 60: 40 (60 marks University exam and 40 marks Departmental internal exam. Continuous assessment)
Passing standards	:40% in each exam separately (separate head of passing)
Evaluation mode	: CGPA
Total Credits of the program	: 120

Program Objectives for B.Sc. Program:

1. To make the students well-versed in broad range of topics in sciences with concentration in one of the sciences.
2. To develop problem-formulation and problem-solving abilities through laboratory experiments with the help of modern techniques, tools, methodologies, equipment, hardware/software etc.
3. To build personality development skills like study and time management, communication, leadership, teamwork along with inculcating social, environment care and universal human values.
4. To make the students to utilize the skills and knowledge gained through the subject to deal with real life situations and problems related to society, environment, research and development etc.
5. To encourage the students to undertake their future education and career in a specific science discipline or in multidisciplinary context.

Program Outcomes (PO) for B.Sc. Program:

Upon successful completion of the B.Sc. program, the graduate student will be able to:

PO No.	PO	Cognitive level
PO1	Apply fundamental and advanced knowledge and expertise in order to produce competent, creative and imaginative human resource with a strong scientific acumen.	03
PO2	Develop the skills in planning and conducting scientific experiments, handling scientific data, analyze it critically and systematically and draw the objective conclusions	03
PO3	Appraise various skills such as communicative, managerial, leadership, entrepreneurship, teamwork, social etc., which will help in expressing ideas and views clearly and effectively	05
PO4	Propose the appropriate model/solution to real-life problem by applying theories learned, modern techniques, methodologies, scientific tools, software etc.	06
PO5	Apply subject knowledge to become competent professionals at professional and social level.	04
PO6	Inculcate the scientific temperament, integrate knowledge of core and allied courses to comprehend the multi-disciplinary nature of the subject to solve scientific problems	05

Program Specific Objectives (PSOs): B.Sc. (Actuarial Science)

Through this degree program

1. Students are expected to learn mathematical methods useful in Actuarial Science, Principles of Insurances, Statistical Methods.
2. Students are expected to learn fundamental concepts of Economics, Accounts & Finance and Financial Economics.
3. Students are expected to learn fundamental concepts of Financial Mathematics, Survival Models, Life Contingencies, Stochastic Models and Loss Models useful in modelling of Actuarial data sets.
4. Students will be trained to use computer programming and statistical software to solve Actuarial problems.
5. Students will be guided to appear for examinations of Institute of Actuaries to increase their employability.

Program Specific Outcomes for B.Sc. (Actuarial Science)

After completion of the B.Sc. (Actuarial Science) program, the students should be able to:

Program Specific Outcome (PSO) No.	Program Specific Outcome	Cognitive Level
PS01	Understand basic concepts of Mathematical methods and probability distributions useful in Actuarial Science	2
PS02	Explain different statistical methods theoretically and their practical applications.	3
PS03	Understand basic principles of Insurances, Financial Mathematics and role of actuary in Insurance field.	2
PS04	Explain different survival models, Stochastic Models, Loss distribution models useful in Actuarial modelling.	3
PS05	Describe basic concepts of Economics, Accounts & Finance, Financial Economics useful in Actuarial Science	2
PS06	Analyze Statistical and Actuarial data by using computer programming and Statistical software	4

AS-101-Calculus

Course Objectives (CObs):

- To learn the concepts of basic topological objects such as open sets, closed sets, compact sets
- To understand the concept of convergence of sequence, series, functions and sequences of functions
- To work comfortably with continuous, differentiable and Riemann integrable functions.

Detailed Syllabus:

Unit I (18 L)

Differential Calculus: Limits of function, continuous functions, properties of continuous functions, partial differentiation and total differentiation. Indeterminate forms: L-Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables, constrained optimization techniques (with Lagrange multiplier) along with some problems. Jacobian, concavity and convexity, points of inflexion of function, singular points.

Unit II (18L)

Integral Calculus: Review of integration and definite integral. Differentiation under integral sign, double integral, change of order of integration, transformation of variables. Beta and Gamma functions: properties and relationship between them.

Unit III (18L)

Differential Equations: Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations solvable for x , y , q , Equations of the first degree in x and y , Clairaut's equations. Higher Order Differential Equations: Linear differential equations of order n , Homogeneous and non-homogeneous linear differential equations of order n with constant coefficients, Different forms of particular integrals, Linear differential equations with non-constant coefficients, Reduction of order method, The Cauchy-Euler's equation of order n , Legendre's linear equation.

Unit IV (6L)

Formation and solution of a partial differential equations. Equations easily integrable. Linear partial differential equations of first order.

References

1. Gorakh Prasad, Differential Calculus, Pothishala Private Ltd, Allahabad
2. Shanti Narayan, Differential Calculus, S. Chand and company, Delhi.
3. Ayres F. Jr.: Calculus, Schaum Outline Series, McGraw Hill 1981.
4. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad (14th Edition - 1997).
5. Gorakh Prasad: Integral Calculus, PothishalaPvt. Ltd., Allahabad (14th Edition 2000).
6. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi (2nd Edition -2004).

7. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.
8. Murray R. Spiegel, Theory and Problems of Advanced Calculus, Schaum Outline Series, Schaum Publishing co., New York.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS101.1	Understand the notions of limit of a sequence and convergence of a series of real numbers.	02
AS101.2	Calculate the limit and examine the continuity of a function at a point.	04
AS101.3	Understand the consequences of various mean value theorems for differentiable functions.	02
AS101.4	Sketch curves in Cartesian and polar coordinate systems.	03

AS-102-Linear Algebra

Course Objectives (COs):

- To understand the vector spaces and subspaces and important concepts of vector spaces such as independence, basis, dimensions, orthogonality etc.
- To understand the link between linear transformation, its properties and matrices, matrix-operations; the spaces associated with matrices and interrelation between them, rank-factorization, eigen and spectral analysis of a matrix.
- To determine the existence and uniqueness of the solution of a linear system of equations, solution set and determining all possible solutions using generalized inverse, Quadratic forms and their definiteness categories, maxima/minima etc

Detailed Syllabus:

Unit I (6L)

Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis, dimension theorem.

Unit II (18L)

Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices. Adjoint and inverse of a matrix and related properties.

Unit III (18L)

Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Symmetric and Skew symmetric determinants, Circulant determinants and Vandermonde determinants for nth order, Jacobi's Theorem, product of determinants. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations $AX=B$, solution sets of linear equations, linear independence, Applications of linear equations, inverse of a matrix.

Unit IV (18L)

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Generalized inverse(concept with illustrations).Partitioning of matrices and simple properties. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem, Quadratic forms, Linear orthogonal transformation and their digitalization.

References

1. Lay David C.: Linear Algebra and its Applications, Addison Wesley, 2000.
2. Schaum's Outlines : Linear Algebra, Tata McGraw-Hill Edition, 3rd Edition, 2006.
3. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V) 1976.
4. Jain P.K. and Khalil Ahmad: Metric Spaces, Narosa Publishing House, New Delhi, 1973
5. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International, 1997.
6. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons, 2008.
7. Artin M.: Algebra. Prentice Hall of India, 1994.
8. Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., 2002.
9. Hadley G.: Linear Algebra. Narosa Publishing House (Reprint), 2002.
10. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley & Sons., 1982
11. A. Ramachandra Rao and P. Bhimasankaram (2000), Linear Algebra, Hindustan Book Agency, Delhi.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS102.1	Understand the concept of linear independence, bases and dimension associated with vector spaces, dimensionality theorem etc.	02
AS102.2	Determine ranks and existence of left, right and proper inverses, rank inequalities under matrix operations, different factorizations of a matrix, solve linear systems etc	03
AS102.3	Construct the orthogonal matrix associated with a non-singular matrix through Gram-Schmidt orthogonalization, diagonalization of a symmetric matrix, the role of eigenvalues, eigenvectors, Cayley Hamilton theo. in theory of matrices etc.	03

AS-103-Descriptive Statistics**Course Objectives (COs):**

- To make the students aware of various types of data, their organization and graphical representations.
- To evaluate summary measures such as central tendency, dispersion, skewness and kurtosis.
- Knowledge of analysis of bivariate data using correlation and regression techniques.
- To make the students aware of statistics in construction of index numbers. .

Detailed Syllabus:

Unit I (15L)

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement nominal, ordinal, interval and ratio. Presentation: tabular and graphical, including histogram and ogives, consistency and independence of data with special reference to attributes.

Unit II (15L)

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, Moments, absolute moments, factorial moments, skewness and kurtosis, Sheppard's corrections. Measures of inequality: Gini's coefficient and Lorenz Curve.

Unit III (15L)

Bivariate data: Definition, scatter diagram, simple, partial and multiple correlation (3 variables only), rank correlation. Simple linear regression, principle of least squares and fitting of polynomials and exponential curves.

Unit IV (15L)

Index Numbers: Definition, construction of index numbers and problems thereof for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth-Marshall and Fisher's. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers.

References

1. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.
2. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1996): Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
3. Goon, A. M., Gupta, M. K. and Dasgupta, B. (2002). Fundamentals of Statistics, Vol. I and II, 8th Edition, the World Press Pvt. Ltd., Kolkata.
4. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.
5. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
6. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
7. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentice Hall of India, New Delhi.
8. Snedecor G. W. and Cochran W. G. (1989). Statistical Methods, Eighth Ed. East-West Press.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS103.1	Understand knowledge of statistics and its application in various areas such as actuarial science, engineering, social sciences etc.	02
AS103.2	Use summary measures such as central tendency, dispersion with their interpretations for explaining the data more effectively	03
AS103.3	Apply knowledge of correlation and regression techniques for real life data and understand their interpretations.	03
AS103.4	Interpret and construct various index numbers.	03

AS-104-Probability Distributions-I**Course Objectives (CObs):**

- To understand difference between random and non-random experiments.
- To study basic concepts of probability, random variable and probability distributions.
- To introduce standard discrete random variables and their probability distributions including expectations and moments.
- To study bivariate distributions and determination of marginal and conditional distributions from bivariate distributions.

Detailed Syllabus:

- Random experiment: trial, sample point and sample space, event, Operations of Events, concepts of mutually exclusive and exhaustive events. (6L)
- Definition of probability: classical and relative frequency approach. Discrete probability space, Properties of probability, Independence of events, Conditional probability, total and compound probability rules, Bayes' theorem and its applications. (12L)
- Discrete random variable (rv): its probability mass function (pmf) and cumulative distribution function (cdf). Joint pmf of several discrete rvs. Marginal and conditional pmfs. Independence of rvs. Expectation of a rv and its properties. Moments, measures of location and dispersion of a rv. Probability generating function (pgf) and moment generating function (mgf) of a rv, their properties and uses. (10L)
- Standard univariate discrete distributions: degenerate, Bernoulli, discrete uniform, binomial, hypergeometric, Poisson, geometric and negative binomial distributions, reproductive property of standard distributions. (15L)
- Bivariate discrete distributions: Bivariate Binomial, Bivariate Poisson, Bivariate Negative Binomial, Marginal and conditional distributions. (12L)
- Distributions of functions of discrete random variables. (5L)

References:

1. Chung, K. L. (1979). Elementary Probability Theory with Stochastic Processes, Springer International Student Edition.
2. David Stirzaker (1994). Elementary Probability, Cambridge University Press.
3. Feller, W. (1968). An Introduction to Probability Theory and Its Applications, Wiley.
4. Hogg, Robert V. & Craig Allen T. (2008). Introduction to Mathematical Statistics, Pearson Education.
5. Mukhopadhyay, P. (1996). Mathematical Statistics, New Central Book Agency, Calcutta.
6. Parzen, E. (1960). Modern Probability Theory and Its Applications, Wiley Eastern.
7. Pitman, Jim (1993). Probability, Narosa Publishing House.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS104.1	Identify the features that describes a distribution of data.	02
AS104.2	Understand notion of probability and conditional probability including concept of Bayes' theorem.	02
AS104.3	Apply discrete probability distributions to different situations.	03
AS104.4	Determine marginal and conditional distributions from bivariate distributions.	03

AS-105-Practicals- I**Course Objectives (COs):**

- To understand various mathematical concepts in calculus such as monotonicity, convexity, concavity of various mathematical functions
- To use mathematical software to evaluate integrals and differentiation of functions, characterizations and orthogonalization of matrices, solving system of linear equations etc.
- To evaluate and understand various measures of describing data, presenting, interpreting, comparing data using different graphical tools
- To differentiate various discrete distributions by sketching *pmfs*, *CDFs* for different parameters and demonstrate the effect of change of parameter on shape/spread of the distribution, simulate and describe the data from these distributions etc.

Detailed Syllabus:**A. Practicals based on AS-101 (Calculus) (15 Hrs)**

1. Checking monotonicity of a given function.
2. Curve sketching and checking the convexity/concavity of a function.
3. Evaluation of logarithmic, exponential and trigonometric functions.
4. Integration and differentiation of a given function.
5. Differentiating given function by chain rule.
6. Verification of Extreme value and Mean value theorem.
7. Demonstrating occurrence of maxima and minima of a given function.
8. Approximation for the function of two and three variables.
9. Finding the extreme values of a function of two or more variables.
10. Line integral and double integration of a function.
11. Triple integration of a function.

B. Practicals based on AS-102 (Linear Algebra) (23 Hrs)

1. Checking linearly dependence/independence of set of vectors.
2. Getting vectors in row/column space and null space of the given matrix.
3. Verification of properties of determinant of the matrix.
4. Checking various characterizations of the matrix such as: rank, singularity/nonsingularity, orthogonality, symmetry, definiteness, idempotency etc.

5. Gram-Schmidt orthonormalization and forming an orthogonal matrix of specified order using Gram-Schmidt orthogonalization.
6. Calculating eigen values and eigen vectors of a given matrix.
7. Quadratic forms and their definiteness.

C. Practicals based on AS-103 (Descriptive Statistics) (30 Hrs)

1. Graphical and tabular presentation of data of various types.
2. Classification, tabulation of a given data in one way/multi-way table.
3. Preparing frequency distribution, frequency polygon and ogives.
4. Exploratory data analysis: Bar graphs, histogram, Stem-and- Leaf plots, Box plots, dot plots, multiple bar graphs, Pie chart, Scatter diagram etc.
5. Calculating various measures of central tendency and dispersion.
6. Calculation of correlation coefficient.
7. Calculation of Gini's Coefficient and plotting of Lorenz curve.
8. Any other problems solving.

D. Practicals based on Introduction to Computer and AS-104 (Probability Distributions-I) (22 Hrs)

1. Simulation of some random experiments.
2. Calculation of pmf , CDF , expectation and variance of the given discrete distribution.
3. Plotting of pmf and CDF (step function).
4. Generating random samples from given discrete distribution.
5. Generating random samples from standard discrete distributions such as Binomial, Negative Binomial, Poisson, Hypergeometric etc.
6. Finding marginal and conditional distribution from the given joint distribution.
7. Generating random samples from joint and conditional distributions.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS105.1	Use mathematical software to demonstrate various concepts in calculus and algebra through sketching, evaluating, comparing various functions/mathematical quantities	03
AS105.2	Describe, interpret, compare real-life datasets using descriptive statistics	03
AS105.3	Simulate the data from various discrete distributions and compare various sample and population quantities, empirical and actuals $pmfs$ and $CDFs$.	03

AS-106-Effective Communication in English

Course Objectives (CObs):

- To introduce various types of oral communication and make them aware about Phonology of English
- To acquaint them with conversation skills, presentations and group discussions.
- To let them study various types of written communications and practice through variety of exercises

Detailed Syllabus:***Effective Oral Communication***

1. Theory of Communication (10L)
 - Verbal, Nonverbal Communication
 - Functions of Communication
 - Models of Communication
 - Effective Communication
 - Miscommunication
2. The Phonology of English (8L)
 - Physiology of Speech
 - Difficulties of Indian learners regarding Vowels,
 - Diphthongs, Consonants
 - Phonemes, Allophones, Syllabic Consonants
 - Assimilation and Elisions
 - Word Accent, Stress, Intonation
 - Varieties of English
 - Phonemic and Phonetic Transcription
3. Conversation Skills (5L)
 - Formal, Informal
 - English for Situations
 - Interviews
 - Meetings
4. Public Speaking, Presentations & Group Discussions (2L)

Effective Written Communication

1. Academic & Analytical Writing (7L)
 - Resumes and CVs
 - Project Proposals
 - Research Articles
 - Referencing
2. Writing for the Media (6L)
 - Difference between print and electronic media
 - Different kinds of writing like news writing, feature writing, investigative reports, current news, human interest stories, subediting, proof-reading symbols.
 - Script writing for radio and television.
3. Technical Writing (7L)
 - Technology in communication
 - Effective use of available technology
 - Writing instructions
 - Technical description
 - Writing for the web
 - Instructions manuals

References

1. Gerson, J. Sharori Technical writing, process and product, Pearson Education Reprint-2004.
2. Betty Kirkpatrick: The concise Oxford Thesaurus. OUP, 24th Impression 2003.
3. Arnold, G.F. &Gimson, A.C., 'English Pronunciation Practice', London: Hodder and Stoughton.
4. Bansal, R.K., 'The Intelligibility of Indian English', Orient Longman.
5. Bolinger, D. 'Aspects of Language', New York, Harcourt, Brace and World Inc., 1968.
6. Miller, George A., 'Language and Communication', New York: Mc Graw Hill.
7. Booher, Dianna E-writing, 21st -century tools for effective communication, Macmillan India Ltd Reprint-2008.
8. Mohan, Krishna & Banerji, Meera Developing Communication Skills, Macmillan India Ltd Reprint-2007.
9. Vilanilam, J. V. More Effective Communication (A Manual for Professionals), Response Books, New Delhi (2003).
10. *Fluency in English* - Part II, Oxford University Press, 2006.
11. *Business English*, Pearson, 2008.
12. *Language, Literature and Creativity*, Orient Blackswan, 2013.
13. *Language through Literature* by Gauri Mishra, Ranjana Kaul and Brati Biswas.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS106.1	Understand various types of communication and Phonology of English	02
AS106.2	Practice various communication, presentation, writing skills in day-to-day activities.	03
AS106.3	Summarize and report confidently with the help of verbal technical English communication skills	05

AS-201-Mathematical Analysis

Course Objectives (CObs):

- To understand basic properties of real number system such as least upper bound property and Order property.
- To realize importance of bounded, convergent, Cauchy and monotonic sequences of real numbers, find their limit superior and limit inferior.
- To learn about Riemann integrability of bounded functions and algebra of R-integrable functions.

Detailed Syllabus:

Unit-I (24L)

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighborhoods and limit

points, Supremum and infimum, derived sets, open and closed sets, sequences and their convergence, limits of some special sequences such as r^n , $\left(1 + \frac{1}{n}\right)^n$ and $n^{\frac{1}{n}}$ Cauchy's general principle of convergence, Cauchy's first theorem on limits, monotonic sequences, limit superior and limit inferior of a bounded sequence.

Unit-II (24L)

Infinite series, positive term series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, Gauss test, Cauchy's condensation test and integral test (Statements and Examples only). Absolute convergence of series, Leibnitz's test for the convergence of alternating series, Conditional convergence. Indeterminate form, L'Hospital's rule.

Unit-III (12L)

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with Lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions of $\sin(x)$, $\cos(x)$, e^x , $(1+x)^n$, $\log(1+x)$.

References

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi, 1994.
2. Somasundram D. and Chaudhary B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1987.
3. Gupta S.L. and Nisha Rani: Principles of Real Analysis, Vikas Publ. House Pvt. Ltd., New Delhi, 1995.
4. Appostol T.M.: Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1987.
5. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi, 1987.
6. Singal M.K. and Singal A.R.: A First Course in Real Analysis, 24th Edition, R. Chand & Co., New Delhi, 2003.
7. Bartle, R. G. and Sherbert, D. R. (2002): Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pte. Ltd., Singapore.
8. Ghorpade, Sudhir R. and Limaye, Balmohan V. (2006): A Course in Calculus and Real Analysis, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS201.1	Understand basic properties of real number system such as least upper bound property and Order property, boundedness, convergence, Cauchy and monotonic sequences of real numbers, find their limit superior and limit inferior.	02
AS201.2	Apply various tests to determine convergence and absolute convergence of a series of real numbers.	03

AS201.3	Determine various applications of the fundamental theorem of differential and integral calculus.	03
AS201.4	Relate concepts of uniform continuity, differentiation, integration and uniform convergence.	03

AS-202-Probability Distributions-II

Course Objectives (CObs):

- To understand concept of continuous distributions with real life examples and to introduce various continuous distributions.
- To study method of obtaining distribution of transformed variables.
- To study bivariate distributions and determination of marginal and conditional distributions from bivariate distributions.

Detailed Syllabus:

- Review of discrete random variable and discrete probability distributions. (4L)
- Continuous random variable, probability density function and cumulative distribution function and cumulative distribution functions of continuous random variables. (4L)
- The Uniform, Normal distributions, gamma distribution and its special cases: the exponential and chi-square distributions, Expected values, variance and moment generating functions of continuous random variables, problems and examples.(16L)
- Other univariate continuous probability distribution: lognormal, Weibull, Laplace, Beta distributions. (16L)
- Relation between different distributions. (6L)
- Functions of Random Variables, including the method of transformation (Jacobian method) and the method of moment generating functions for more than one random variable, Order Statistics and their applications. (6L)
- Joint distribution of random variables, marginal, conditional distribution, conditional expectations etc. (6L)
- Limiting and approximations of distribution. (2L)

References

1. Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
2. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
3. Ross S. (2002). A First Course in Probability, Sixth Edition, Pearson Education, Inc. & Dorling Kindersley Publishing, Inc.
4. Hogg, R.V., Tanis, E.A. and Rao J.M. (2009): Probability and Statistical Inference, Seventh Ed, Pearson Education, New Delhi.
5. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, New Delhi.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS202.1	Understand and apply continuous probability distributions to different situations.	02
AS202.2	Understand concept of transformation of random variables and its method to obtain their distributions.	02
AS202.3	Construct the relation between various continuous distributions.	03
AS202.4	Determine marginal and conditional distributions from bivariate distributions.	03

AS-203-Principles of Microeconomics**Course Objectives (COs):**

- Basic understanding of the principles of microeconomics.
- To understand the operation of a market economy and the problem of how best to allocate society's scarce resources
- To explore how firms decide how much to use their resources (land, labor, capital, and entrepreneurial ability), which are required to produce a final good, and at what price.
- To understand the laws of supply and demand, and introduces the theory of the firm, and its components, production and cost theories and models of market structure.
- To understand the various causes of market failure are assessed, and consideration is given to public policies designed to correct this market failure
- To models of how individuals and firms interact within markets, when markets fail.
- How government policy may improve outcomes for society.

Detailed Syllabus:

- Introduction: Nature and scope of economics; Methodology in economics; Choice as an economic problem; Production possibility frontier (curve); basic postulates; Role of price mechanism; Demand and supply; Basic framework — applications; Market equilibrium; Elasticity of demand- Price, income and cross; Consumer's surplus; Engel curve. (12L)
- Consumer's Behavior: Choice and Utility theory- Cardinal and ordinal approaches; Law of diminishing marginal utility; Indifference curve; Consumer's equilibrium (Hicks and Slutsky); Substitute and Income effect; Consumer and producer surplus and their application; Giffin goods; Compensated demand. (12L)
- Theory of Production and Costs: Production decisions; Production function; Average and marginal production; Iso-quant; Factor substitution; law of variable proportions; returns to scale; economies of scale; Different concepts of cost and their interrelation; Equilibrium of the firm; Expansion path; Empirical evidence on costs. (8L)
- Market Structure: Market forms — Perfect and imperfect markets; Equilibrium of a firm — Perfect competition, monopoly and price discrimination; Measure of monopoly power; Monopolistic competition; Duopoly, Oligopoly; Profit maximization condition; Taxation and equilibrium of a firm; Notion of controlled and administered prices. (8L)
- Factor Pricing: Marginal productivity theory of distribution; Theories of wage determination; Wages and collective bargaining; Wage differentials; Rent - Scarcity rent;

Differential rent; Quasi rent; Interest-Classical and Keynesian theories; Profits - Innovation, risk and uncertainty theories. (10L)

- Investment Analysis: Payback period-average annual rate of return, Net present value, Internal rate of return criteria, price changes, risk and uncertainty, elements of social cost-benefit analysis. (5L)
- Welfare Economics: Problems in measuring welfare; Classical welfare economics; Pareto's criteria; Value judgment; Concept of a social welfare function; Compensation principle — Kaldor, Hicks. (5L)

References

1. CT-7 Study material of Institute of Actuaries of India.
2. Henderson J. and R.E. Quandt (1980), Microeconomic Theory: A Mathematical Approach, McGraw Hill, New Delhi.
3. Heathfield and Wibe (1987), An Introduction to Cost and Production Functions, Macmillan, London.
4. Lipsey, R.G. and K.A. Chrystal (1999), Principles of Economics (9th Edition), Oxford University Press, Oxford.
5. Mansfield, E. (1997), Microeconomics (9th Edition), W.W. Norton and Company, New York.
6. Samuelson, P.A. and W.D. Nordhaus (1998), Economics, Tata McGraw Hill, New Delhi.
7. Stonier, A.W. and D.C. Hague (1972), A Textbook of Economic Theory, ELBS & Longman Group, London.
8. Varian, H.R. (2000), Intermediate Microeconomics: A Modern Approach (5th Edition), East-West Press, New Delhi.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS203.1	Explain how competitive markets organise the allocation of resources and the distribution of goods and services	04
AS203.2	Assessthe efficiency of markets and describe the various factors that might impact on efficiency	05
AS203.3	Distinguish between the various forms of market failure and explain how governments might need to intervene.	05
AS203.4	Describethethe various types of markets and compare their efficiency	02

AS-204-Principles and Practices in Insurance

Course Objectives (COs):

- To provide students with the knowledge of general principles and practices of insurance and to understand the Insurance Mechanism.
- Identify the relationship between Insurers and their Customers and the importance of Insurance Contacts.
- To understand the theories, regulatory framework of insurance, types of insurance, and the major types of insurance products.
- To understand the rule and working of actuaries in insurance sector.

Detailed Syllabus:

- Principles of Life Insurance: Nature of Insurance, Classification of Insurance Economic value of Earning Head of the Household, Basic Insurance Protection, Business use of Life Insurance, Basic elements of life insurance contracts, Insurable interest, Need for utmost good faith, disclosure of Material Facts, Warrant, Tax advantages of Certain Assurance, Wealth Tax. (12L)
- Selection and classification Risks, Objectives for selection and classification of risks, factors relating to Physical Hazard, Factors relating to occupational Hazards and Moral Hazard, Source of Information, Insurance of female lives, rating of female lives.(12L)
- Investment of life fund: Investment of LIC, Investment of life Insurance Fund, basic principles, statutory requirements of investments, people's money for peoples welfare valuation, purpose and types. (8L)
- Policy conditions and Privileges, calculation of paid up values, Surrender values, Loans, Foreclosure Alterations, Distribution of loans, Calculations of Vested bonus, Interim bonus, Final bonus, settlement of Claims, calculation of benefit payable on, Maturity claims, Death claims and adjustment for loans, unpaid premium and interest. (10L)
- General Insurance: Need for general insurance, Types of general insurance, Fire Insurance, Marine Insurance, Motor Insurance, Liability Insurance, Aviation Insurance, Engineering Insurance, Burglary Insurance, Mediclaim and project Insurance, Loss of profit Insurance. (10L)
- Principles of general Insurance, Privatization of Insurance in India, IRDAI and role of IRDAI. (8L)

References

1. Kenneth Black Jr. and Harold D. Skipper (1999) Life and Health Insurance.(13th Ed.)
2. Principles and Practice of Life Insurance-Insurance Institute of India
3. Principles and General Insurance- Insurance Institute of India
4. Narang, Uma, Insurance Industry in India: Features, Reforms and Outlook, NewCentury Publications.
5. Periasamy P (2014) Principles and Practice of Insurance, Himalaya Publishing House.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS204.1	Identify what insurance is, why insurance works and how to determine insurance needs.	02
AS204.2	Explain insurance operation, including functions of insurance, insurance markets, insurance regulations and the use of insurance as a tool to avoid losses and reduce risk.	04
AS204.3	Explain major insurance products, such as life insurance, health insurance, property and liability insurance.	04
AS204.4	Compare various kinds of insurance plans as well as the contract selection criteria from a cost-benefit point of view.	04
AS204.5	Understand how actuaries work in Insurance sector	02

AS-205-Practicals-II

Course Objectives (CObs):

- To fit suitable discrete/continuous distribution to the given data, to compare various continuous distributions by sketching *pdfs*, *CDFs*, sample quantities based on simulation with respective population quantities
- To fit suitable regression model for the given set of response and predictor variables, calculate multiple/partial correlation coefficients.
- To understand various concepts in microeconomics through various plots such as PPF, demand and supply curve, total, marginal and average cost curve etc and solving various profit maximization problems.

Detailed Syllabus:

- A. Practicals based on AS-202 (Probability Distributions-II) (45 Hrs)**
1. Fitting of binomial distributions for n and $p = q = \frac{1}{2}$.
 2. Fitting of binomial distributions for given n and p .
 3. Fitting of binomial distributions after computing mean and variance.
 4. Fitting of Poisson distributions for given value of λ .
 5. Fitting of Poisson distributions after computing mean.
 6. Fitting of negative binomial.
 7. Fitting of suitable distribution.
 8. Application problems based on binomial distribution.
 9. Application problems based on Poisson distribution.
 10. Application problems based on negative binomial distribution.
 11. Plotting of PDF and CDF of a continuous random variable.
 12. Problems based on area property of normal distribution.
 13. To find the ordinate for a given area for normal distribution.
 14. Application based problems using normal distribution.
 15. Fitting of normal distribution when parameters are given.
 16. Fitting of normal distribution when parameters are not given.
 17. Generating random sample from given continuous distribution.
 18. Generating random sample from standard distributions such as Normal, Uniform Gamma, exponential etc.
 19. Generating random sample from joint and conditional distribution.
 20. Computing various functions of sample observations based on random samples drawn from any continuous distribution.
 21. Finding marginal and conditional distribution from the given joint distribution.
 22. Generating random samples from joint and conditional distributions.
 23. Verification of approximation of distributions
- B. Practicals based on AS-103 (Descriptive Statistics) (30 Hrs)**
1. Fitting of linear and quadratic regression models.
 2. Fitting of polynomials by using transformations.
 3. Calculating of multiple and partial correlation coefficients.
 4. Intraclass correlation coefficient with equal and unequal group sizes.
 5. Fitting of multiple linear regression models.
 6. Testing independence of attributes.

7. Analysis of categorical data using odds ratio.
8. Other problems solving

C. Practicals based on AS-203 (Principles of Microeconomics) (15 Hrs)

1. Pareto criteria/analysis.
2. Plotting of production possibility frontier (PPF)
3. Plotting demand and supply curve and determination of equilibrium point.
4. Computation of consumer and producer surplus.
5. Calculation and sketching of total, marginal and average cost curve.
6. Sketching of utility functions.
7. Problems based on investments, variation in interest rates, risks etc.
8. Solving Profit maximization problem under following market structures:
Perfectly competitive, Monopoly, Oligopoly and Monopolistic.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS205.1	Choose suitable discrete/continuous distribution to fit to the given data along with measure of goodness of fit	05
AS205.2	Set up a suitable regression model to given real-life data and use/interpret it for prediction.	05
AS205.3	Calculate various quantities in microeconomics such as consumer and producer surplus, studying sensitivity of demand-supply, total, marginal and average cost etc.	04

AS-206 - Environmental Studies

Course Objectives (CObs):

- Provide students with the scope to develop knowledge base covering all attributes of the environment and enable them to attain scientific/technological capabilities to find answers to the fundamental questions before the society with regards to human action and environmental effects with due diligence.
- Enhance the ability to apply this knowledge and proficiency to find solutions relating to environmental concerns of varied dimensions of present times.
- Provide with a direction and technical capability to carry on lifelong learning and show teamwork and collaborative endeavour, and decision making.
- Improve the employability of the graduates including the enhancement of self-employment potential and entrepreneurial aptitude and fill the technical resource gap especially in the Indian context.
- Help graduates appreciate requirement of framing environmental policy guidelines.

Detailed Syllabus:

Unit 1: Introduction to environmental studies (2L)

- Multidisciplinary nature of environmental studies;
- Scope and importance; Concept of sustainability and sustainable development.

Unit 2: Ecosystems (6L)

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems
 - a) Forest ecosystem
 - b) Grassland ecosystem
 - c) Desert ecosystem
 - d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Natural Resources : Renewable and Non-renewable Resources (8L)

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Energy resources: Renewable and non renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

Unit 4: Biodiversity and Conservation (8L)

- Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots.
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

Unit 5: Environmental Pollution (8L)

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Pollution case studies.

Unit 6: Environmental Policies & Practices (7L)

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
- Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit 7: Human Communities and the Environment (6L)

- Human population growth: Impacts on environment, human health and welfare.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquake, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit 8: Field work (Equal to 5 lectures)

- Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

References:

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2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
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15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger. A Natural History of the Indian Subcontinent*.
18. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E. O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS206.1	Recognize the need for learning the topic and develop foundational knowledge on the environmental issues.	01
AS206.2	Develop critical thinking and problem solving skills to solve interdisciplinary issues related to the topic.	03
AS206.3	Apply statistical methods, ICT and innovative techniques in classroom, field and laboratory to analyze scientific data and ability to develop lifelong learning and professional skills.	03
AS206.4	Design and execute a scientific project, write scientific reports, develop research and communication skills.	06
AS206.5	Understand on the topic and contribute in decision making process.	02

AS-301-Sampling Distributions**Course Objectives (COs):**

- To introduce notion of sampling distribution of a statistic and order statistics
- To describe concept of convergence of sequence of random variables and their applications as WLLN and CLT.
- To build the theoretical foundation of testing of hypothesis.
- To study exact sampling distributions, their application and their interrelations.

Detailed Syllabus:**Unit I (12L)**

Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion.

Order Statistics: Introduction, distribution of the r^{th} order statistic, smallest and largest order statistics. Joint distribution of r^{th} and s^{th} order statistics, distribution of sample median and sample range.

Unit II (12L)

Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof)

Unit III (8L)

Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

Unit IV (12L)

Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different d.f., mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

Unit V (16L)

Exact sampling distributions: Student's t -distribution, Derivation of its p.d.f., nature of probability curve with different d.f., mean, variance, moments and limiting form of t distribution.

Snedecore's F -distribution: Derivation of p.d.f., nature of p.d.f. curve with different d.f., mean, variance and mode. Distribution of $1/F(n_1, n_2)$. Relationship between t , F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

References

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th dn. World Press, Kolkata.
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3. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
4. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4thEdn. John Wiley and Sons.
5. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rdEdn. (Reprint). Tata McGraw-Hill Pub. Co. Ltd.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS301.1	Understand concept of sampling distribution of a statistic and order statistics.	02
AS301.2	Apply concept of convergence of sequence of random variables.	03
AS301.3	Apply WLLN and CLT to solve real life problems.	03
AS301.4	Understand the theoretical foundation of testing of hypothesis and associated concepts.	02
AS301.5	Explain the exact sampling distributions, their application and their interrelations.	04

AS-302-Financial Mathematics**Course Objectives (COs):**

- To understand various Mathematical concepts applicable in the area of Insurance
- Learn some elementary concepts in Financial Statistics leading to generalized cash flow models
- Learn Some advanced level concepts such as compound interest function including level and non-level annuities, continuous payment cashflows etc.
- Investment and risk characteristics involved with different types of assets

Detailed Syllabus:

- The measurement of interest: (8L)
Introduction, The accumulation and amount functions, The effective rate of interest, Simple interest, Compound interest, Present value, The effective rate of discount, Nominal rates of

interest and discount, Forces of interest and discount, Varying interest, Summary of results.

- Solution of problems in interest: (6L)
Introduction, The basic problem, Equation of value, Unknown time, Unknown rate of interest, Determining time periods, Practical examples.
- Basic annuities: (8L)
Introduction, Annuity-immediate, Annuity-due, Annuity values on any date, Perpetuities, Unknown time, Unknown rate of interest, Varying interest, Annuities not involving compound interest.
- More general annuities: (8L)
Introduction, Differing payment and interest conversion periods, Annuities payable less frequently than interest convertible, Annuities payable more frequently than interest convertible, Continuous annuities, Payments varying in arithmetic progression, Payments varying in geometric progression, More general varying annuities, Continuous varying annuities, Summary of results,
- Amortization schedules and sinking funds: (8L)
Introduction, Finding the outstanding loan balance, Amortization schedules, Sinking funds, Differing payment periods and interest conversion periods, Varying series of payments, Amortization with continuous payments, Step-rate amounts of principal.
- Bonds and other securities: (8L)
Introduction, Types of securities, Price of a bond, Premium and discount, Valuation between coupon payment dates, Determination of yields rates, Callable and puttable bonds, Serial bonds, some generalizations, other securities, Valuation of securities.
- Yield rates: (8L)
Introduction, Discounted cash flow analysis, Uniqueness of the yield rate, Reinvestment rates, Interest measurement of a fund, Time-weighted rates of interest, Portfolio methods and investment year methods, Short sales, Capital budgeting-basic technique and other technique.
- The term structure of interest rates: (6L)
Introduction, Yield curves, Spot rates, Relationship with bond yields, Forward rates, Arbitrage, A continuous model.

References

1. Kellison Stephen G., The Theory of Interest, 3rd Edition. McGraw-Hill International Edition (2009).
2. Elliott R.J. and Kopp P.E. Mathematics of Financial Markets. Springer.1999

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS302.1	Understand Mathematical concepts applicable in the area of Insurance Industry	02
AS302.2	Apply compound interest function including level and non-level annuities, continuous payment cashflows etc.	03
AS302.3	Generalize different types of cash flow models	02
AS302.4	Compare Investments and risk characteristics involved with different types of assets.	05

AS-303-Principles of Macroeconomics

Course Objectives (CObs):

- To understand the basic of knowledge of unemployment, inflation, and the business cycle, Interaction of labour, money, and goods and services markets can be developed
- To understand the process by which the levels of economic activity, employment and rates of interest are jointly determined
- To examine how the policies set by the central bank and the government affect the economy.
- To give students insight into the dynamics of national economy.
- To understand the effects of government spending and taxation policies and the effects of the monetary policy carried out by the Reserve Bank.

Detailed Syllabus:

- National Income and Social Accounts: Concept and measurement of national income; National income identities with government and international trade; incorporation of environmental concerns in national accounts — green accounting. Macroeconomic Policy in a monetary Economy: Money and monetary institutions; The role of money in Macroeconomics; Microeconomic policy in an open economy. (18L)
- Output and Employment: Say's law of markets and the classical theory of employment; Keynes' objection to the classical theory; Aggregate demand and aggregate supply functions; The principle of effective demand; Consumption function — Average and marginal propensity to consume; Factors influencing consumption spending; The investment multiplier and its effectiveness in LDCs; Theory of investment— Autonomous and induced investment; Marginal efficiency of capital; Savings and investment — ex post and ex ante, Equality and equilibrium.
Rate of Interest: Classical, Neo-classical and Keynesian theories of interest. (18L)
- Trade Cycles: Nature and characteristics; Hawtrey's monetary theory; Hayek's over-investment theory; Keynes' view on trade cycle; The concept of accelerator and multiplier model; Fiscal policy in multiplier model; Samuelson and Hicks multiplier-accelerator interaction model; Control of trade cycles; Beyond the multiplier model. (12L)
- Economic Growth: Sources of growth; trend and cycle of Growth models - Harrod and Domar; Benefits and costs of growth theories of economic growth; Instability of equilibrium; Neo-classical growth models — Solow; Economic growth and technical progress; International trade. (12L)

References

1. Ackley, G. (1976), Macroeconomics: Theory and Policy, Macmillan Publishing Company, New York.
2. Gupta, S.B. (1994), Monetary Economics, S. Chand and Co., Delhi.
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6. Lucas, R. (1981), Studies in Business Cycle Theory, MIT Press, Cambridge, Massachusetts.
7. Lipsey, R.G. and K.A. Chrystal (1999), Principles of Economics (9th Edition), Oxford University Press, Oxford.

8. Samuelson, P.A. and W.D. Nordhaus (1998), Economics, Tata McGraw Hill, New Delhi.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS303.1	Understand the meaning of unemployment and inflation data and how that data is collected and computed;	02
AS303.2	Explain the components of the National Income Accounts, especially GDP; business cycle and its phases; reserve banking system	04
AS303.3	Analyze the basic Aggregate Supply, Aggregate Demand model of the macro economy;	04
AS303.4	Compare fiscal policy operates, tools, and advantages and drawbacks;	04
AS303.5	Compare the monetary policies, its tools, and its advantages and drawbacks.	04

AS-304-R Programming and Numerical Methods

Course Objectives (CObs):

- To review the core topics in probability and statistics through the study and practice of data analysis and graphical interpretation using 'R'.
- Students will learn R-reporting and developing own R code/packages/ Apps.

Detailed Syllabus:

Unit I (12L)

- Introduction to R - A programming language and environment for data analysis and graphics.
- Syntax of R expressions: Vectors and assignment, vector arithmetic, generating regular sequence, logical vector, character vectors, Index vectors; selecting and modifying subsets of data set
- Data objects: Basic data objects, matrices, partition of matrices, arrays, lists, factors and ordered factors, creating and using these objects; Functions- Elementary functions and summary functions, applying functions to subsets of data.
- Data frames: The benefits of data frames, creating data frames, combining data frames, Adding new classes of variables to data frames; Data frame attributes.

Unit II (12L)

- Importing data files: import.data function, read.table function; Exporting data: export.data function, cat, write, and write.table functions; Outputting results - sink function, formatting output - options, and format functions; Exporting graphs - export.graph function.
- Graphics in R: creating graphs using plot function, box plot, histogram, line plot, steam and leaf plot, pie chart, bar chart, multiple plot layout, plot titles, formatting plot axes; 3-D plots: Contour plots, perspective plots, and image plots: Visualizing the multivariate data: Scatter plot matrices, Star plots, Faces
- Interactively adding information of plot - Identifying the plotted points, adding trend lines to current scatter plot, adding new data to current plot, adding text and legend
- Loops and conditional statements: Control Statements; if statement, if else Statement. Looping statement; for loop, repeat, while loop

Unit III (12L)

- Developing simple programs in R for data analysis tasks, saving programs, executing stored programs, defining a new binary operator, assignment within function, more advanced examples, object oriented programme. Creating function libraries- library function, attaching and detaching the libraries, R packages and data sets.
- Performing data analysis tasks: Reading data with scan function, Exploring data using graphical tools, computing descriptive statistics, one sample tests, two sample tests, Goodness of fit tests, vector and matrix computation, Defining Statistical Models: Introduction for defining models, Generic functions for extracting model information.

Unit IV (6L)

- Probability and Distributions: Random sampling and combinatory, obtaining density, cumulative density and quantile values for discrete and continuous distributions, generating samples from discrete and continuous distributions, plotting density and cumulative density curves, Q-Q plot.

Unit V (18L)

- Errors in Numerical Calculations: Introduction, Errors and their Analysis, general error formula, error in series approximation.
- Iterative methods: Introduction, bisection, Newton-Raphson method for finding roots of polynomial equation.
- Interpolation: Newtons methods, Lagrangian method, direct method
- Solution of Simultaneous Algebraic Equations: Introduction, Direct method, Matrix Inversion Method, Jacobi iteration method, Gauss elimination method, Pivoting, Gauss-Seidel iterative method, Gauss Jordan method, Eigen value Problem.
- Numerical Integration: Introduction, Simpson's 1/3 rule, Trapezoidal rule, Quadrature rule, Simpson's 3/8 rule, Errors in integration formulae.

References

1. Peter Dalgaard (2002). Statistics and computing: Introductory Statistics with R (Springer).
2. Purohit, G.S., Gore, S.D. and Deshmikh, S.R. (2008). Statistics Using R (Narosa Publishing House)
3. Maindonald, J. and Braum, J. (2007). Data Analysis and Graphics Using R: An example-based approach (2nd Ed. Cambridge Series in Statistical and Probabilistic Mathematics)
4. Hey-Jahans, C. (2012). An R Companion to Linear Statistical Models (CRC Press)
5. Gardener, M. (2012). Beginning R: The Statistical Programming Language (Wiley & Sons)
6. Acharya, S. (2018). Data Analytics using R (McGraw Hill Education)
7. Wickham, H. and Golemund, G. (2017). R for Data Science (O'Reilly Media)
8. Lander, J.P. (2017). R for Everyone: Advanced Analytics and Graphics (Addison-Wesley Professional)
9. Kabacoff, R.I. (2015). R in Action: Data Analysis and Graphics with R (2nd Ed. Manning Publications)
10. V. Rajaraman (1993). Computer Oriented Numerical Methods, (3rd Ed. Prentice-Hall)
11. W. H. Press, S. A. Teukolsky, W.T. Vetterling and B.P. Flannery (1993). Numerical Recipes in C, (2nd Ed. Cambridge University Press).

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS304.1	Describe R methods/codes/packages/ Apps in R programming	02
AS304.2	Develop various R Programs for actuarial, statistical and financial problems, models and methods	03
AS304.3	Construct the different packages and flowcharts useful in Actuarial field	03

AS-305-Practicals-III**Course Objectives (CObs):**

- To demonstrate the concept of sampling distributions, convergence and verification of WLLN and CLT, understand various decision-making problems through tests of hypothesis of various types
- To calculate various quantities such as present and accumulated values, annuities, work out loan schedule, bonds, securities etc. and their sensitivity with nominal/ effective rate of interest
- To develop R-programs to compare, study some of the standard probability distributions, simulation and description of the sample quantities, solve the problems based on numerical methods.

Detailed Syllabus:

- A. Practicals based on AS-301 (Sampling Distributions) (30 Hrs)**
1. Applications and verification WLLN.
 2. Applications and verification of CLT.
 3. Verification of sampling distribution.
 4. Large sample tests based on Normal distribution.
 5. Testing of significance and confidence intervals for single proportion and difference of two proportions
 6. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
 7. Testing of significance and confidence intervals for difference of two standard deviations.
 8. Exact Sample Tests based on Chi-Square Distribution.
 9. Testing if the population variance has a specific value and its confidence intervals.
 10. Testing of goodness of fit.
 11. Testing of independence of attributes.
 12. Testing of significance and confidence intervals of an observed sample correlation coefficient.
 13. Testing and confidence intervals of equality of two population variances
- B. Practicals based on AS-302 (Financial Mathematics) (30 Hrs)**
1. Calculation of present and accumulated value of simple and compound interest.

2. Relation between nominal, effective and force of interest.
3. Calculation of present and accumulated value of annuities.
4. Problems based on more general annuities.
5. Redemption of loan schedule.
6. Bonds and securities.
7. Yield rates.
8. Practical application.
9. Term structure of interest rates.

C. Practicals based on AS-304 (R programming and Numerical Methods) (30 Hrs)

1. Install and configuration of R programming environment, Basic language elements and data structures, Data input/output, Data storage formats, Subsetting objects, Functions, Loop functions, Graphics and visualization, Statistical simulation
2. Writing R programs to calculate different summary statistics (mean median, mode, variance, standard deviation, order statistics, range and quantiles) based on the given n observations.
3. R Programs to compute and plot p.m.f.'s and c.d.f.'s of standard probability distributions. (Binomial, Poisson, Geometric, Hyper Geometric, Negative Binomial)
4. Drawing random samples from standard distributions (Binomial, Poisson, Geometric, Exponential, Normal, Gamma, Beta, Discrete, Mixture), preparing frequency distribution of given data.
5. Drawing a random sample of size n using SRSWR and SRSWOR.
6. Calculation of double integrals, limits of functions, computing integrals by statistical methods, computing expectations of complicated functions.
7. Calculation of regression and correlation coefficients, ANOVA for one-way and two way models, Analysis of 2×2 contingency table, calculation of p-value for standard normal distribution (for given Z value), box Plot, pie charts, histograms, dot plots, density plots, mean and variance of estimates, calculation of empirical power & level of significance.
8. To locate, install and load R packages
9. Programs based on the numerical methods: Bisection method, Newton-Raphson Method, Numerical Integration by Trapezoidal rule Simpson's rules.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS305.1	Develop software codes to verify the convergences, to demonstrate the sampling distributions and to formulate variety of decision-making problems as appropriate statistical hypothesis and perform its testing	03
AS305.2	Develop own finance products such as loan proposal, bonds and securities etc for given situation	03
AS305.3	Carry out simulation studies for variety of standard probability distributions and apply numerical methods wherever needed	03

AS-401-Mathematical Statistics

Course Objectives (CObs):

- To study principles of data reduction: Sufficiency principle, Likelihood Principle.
- To study important properties of statistics and different methods of estimation techniques.
- To study methods for obtaining optimal estimators in the class of unbiased estimators.
- To build the theoretical foundation of point estimation and testing of hypothesis.
- To study concept of Bayesian inference and non-parametric tests.

Detailed Syllabus:

Unit I (12L)

Sufficiency: Sufficiency, Fisher's concept of sufficiency, Likelihood equivalence, Minimal sufficient Statistic Factorization theorem. Invariance property of sufficiency under one-one transformation of sample space, Exponential and Pitman family of distributions, Fisher information for one and several parameters models.

Unit II (12L)

Estimation: unbiasedness, mean square error, evaluation of point estimators, concept of confidence interval estimation for the difference between two population parameters, confidence interval estimation for the population variance.

Some properties of point estimators, including relative efficiency, consistency, some common method of obtaining point estimators, including the method of moments and maximum likelihood estimation.

Unit III (12L)

Minimum variance unbiased estimation: Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications), Complete statistic, ancillary statistic, Basu's theorem.

Unit IV (12L)

Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

Unit V (12L)

Baysian Estimation: Prior distribution, loss function, principle of minimum expected posterior loss, quadratic and other common loss functions, conjugate prior distributions, common examples.

Non-Parametric tests: Tests of randomness. Sign test, Wilcoxon signed rank test, Kolmogorov-Smirnov test.

References

1. Kale, B.K. and K. Muraridharan (2015) Parametric Inference: An Introduction, Alpha Science Intl Ltd.
2. Rohatgi V.K. and Ehsanes Saleh A.K.MD. (2003). An Introduction to Probability Theory and Mathematical Statistics, (Wiley Eastern, 2nd Ed.).
3. Dudewicz, E.J.and Mishra, S.N. (1988). Modern Mathematical Statistics, (Wiley Sons).

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5. Mood A.M, Graybill F.A. and BoesD.C,: Introduction to the Theory of Statistics, McGraw Hill.
6. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
7. Snedecor G.W and Cochran W.G.(1967) Statistical Methods. Iowa State University Press.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS401.1	Understand sufficiency principle, Likelihood Principle as principles of data reduction.	02
AS401.2	Connect important properties of statistics and its application to inference study. Learn families of distributions such as Exponential family, Pitman family.	04
AS401.3	Estimate unknown parameters using different methods of estimation techniques such as method of moments, maximum likelihood method. Obtain lower bounds for variance of an unbiased estimators and related concept of MVUE, MVBUE.	04
AS401.4	Construct MP test, UMP test, LRT test.	03
AS401.5	Understand the concept of Bayesian inference and non-parametric tests.	02

AS-402-Surveys Sampling & Indian Official Statistics

Course Objectives (CObs):

- To provide knowledge and training of sample surveys, methods of estimations of population parameters under different sampling schemes.
- To make students aware of National Economy and National Indicators of Economy and teach them role of statistics in National Developments.

Detailed Syllabus:

Unit I (12L)

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

Unit II (12L)

Unequal Probability Sampling Designs: Inclusion probabilities, Horwitz-Thompson estimator and its properties, PPSWR, PPSWOR methods (including Lahiri's scheme) and related estimators of a finite population mean (Hansen-Horwitz and Desraj) estimators for a general sample size and Murthy's estimator (for a sample of size 2), Midzuno sampling design, πps design.

Unit III (12L)

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision, post stratification and its performance. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates ($N=nk$). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

Unit IV (12L)

Introduction to Ratio and Regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, variances in terms of correlation coefficient for regression method of estimation and their comparison with SRS. Cluster sampling (equal clusters only) estimation of population mean and its variance, comparison (with and without randomly formed clusters).

Unit V (12L)

Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), National Statistical Office(NSO), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

References

1. Cochran W.G. (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.
2. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C. (1984): Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics
3. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
4. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House
5. Goon A.M., Gupta M.K. and Dasgupta B. (2001): Fundamentals of Statistics (Vol.2),World Press
6. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.
(Refer website-<http://mospi.nic.in/>)

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS402.1	Describe different methods of sampling survey methods and objectives and give examples of situations where these methods are useful.	02
AS402.2	Compute different selection or inclusion probabilities under various sampling schemes.	03
AS402.3	Analyze survey data by using estimation procedures under different sampling methods.	04
AS402.4	Describe estimation of population parameters under different sampling methods.	02
AS402.5	Explain role of official statistics.	02

AS-403-Life Contingencies-I

Course Objectives (CObs):

- To describe the concept of risk and measurement risk models.
- To describe some basic concepts of Financial Mathematics.
- To explain the role of statistical theory while addressing the problem of finding premium under different life insurance contracts.

Detailed Syllabus:

- Introduction to Life Insurance. (2L)
- Survival Distributions and Life Tables: (10L)
Probability for the Age-at-Death, the survival function, time- until-death for a person aged x , curtate-future-lifetime, force of mortality.
Life tables, relation of life table functions to the survival function, life table example.
The deterministic survivorship group, other life table functions, assumptions for fractional ages, some analytical laws of mortality, some analytical laws of mortality, select and ultimate tables.
- Life Insurance: (12L)
Insurances payable at the moment of death: level benefit insurance, endowment insurance, deferred insurance, varying benefit insurance.
Insurances payable at the end of year of death, relationships between Insurances payable at the moment of death and the end of year of death, recursion equation, commutation functions.
- Life Annuities: (12L)
Single payment contingent on survival, continuous life annuities, discrete life annuities, life annuities with mthly payments, commutation function formulas for annuities with level payments, varying annuities, recursion equations, complete annuities-immediate and apportionable annuities-due.
- Net premiums or Benefit premiums (12L)
The random future loss under an assurance or annuity contract, state the principle of equivalence, Notations and formulae of net premium for common life insurance contracts, Fully Discrete Premiums, True m-thly payment premium, Commutation functions, increasing and decreasing Benefit premiums, Profits contract, Types of bonus, Calculating net premiums for with-profit contracts. Gross premium.
- Benefit Reserves (8L)
Prospective and Retrospective Reserves , Net future random loss for reserves, Conditions for equality of prospective and retrospective Reserves, Fully Continuous Benefit Reserves, other formulas for fully Continuous Benefit Reserves, Fully Discrete Benefit Reserves, Benefit Reserves on a Semi-continuous basis, Benefit Reserves based on True m-thly Benefit premiums, Net Premium Reserves, Thiele's Differential Equation, Death strain at risk(DSAR), Expected death strain(EDS), Actual death strain (ADS), Mortality profit, Mortality profit on a portfolio of policies, Calculating net Reserves for with-profit contracts.
- Analysis of Benefit Reserves (4L)
Benefit Reserves for General Insurances, Recursion Relations for Fully Discrete Benefit Reserves, Benefit Reserves at Fractional Durations.

References

1. Bowers, N. L., Gerber, H.U., Hickman, J.C., Jones, D.A., Nesbitt, C.L.(1986), Actuarial Mathematics, The society of actuaries.
2. David, C. M., Dickson, Mary R. Hardy and Howard, R. waters.(2009). Actuarial Mathematics for Life Contingent Risks. Cambridge University Press.

3. Deshmukh, S.R. (2009). Actuarial Statistics, Universities Press India.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS403.1	Identify basic risk available in the problem and formulate suitable loss random variable.	02
AS403.2	Summarize different terms of life tables and their applications in Life Insurance.	02
AS403.3	Apply tools of Financial Mathematics to solve the real-life problems related to investment, loan repayment and life annuities.	03
AS403.4	Simulate data from present value random variables from different life insurances or life annuities to estimate required premium.	03
AS403.5	Formulate new need-based life insurance contract.	06

AS-404-Financial Accounting

Course Objectives (CObs):

- Preparing financial statements in accordance with appropriate standards.
- Interpreting the business implications of financial statement information
- Identifying organizational information technology components and risks that can affect financial systems and prescribing appropriate controls.
- Applying auditing concepts to evaluate the conformity of financial statements with appropriate auditing standards.

Detailed Syllabus:

Unit I:

- a) Theoretical Framework (3L)
- i. Accounting as an information system, the users of financial accounting information and their needs. Qualitative characteristics of accounting, information. Functions, advantages and limitations of accounting. Branches of accounting. Bases of accounting; cash basis and accrual basis.
 - ii. The nature of financial accounting principles – Basic concepts and conventions: entity, money measurement, going concern, cost, realization, accruals, periodicity, consistency, prudence (conservatism), materiality and full disclosures.
 - iii. Financial accounting standards: Concept, benefits, procedure for issuing accounting standards in India. Salient features of First-Time Adoption of Indian Accounting Standard (Ind-AS) 101. International Financial Reporting Standards (IFRS): - Need and procedures.
- b) Accounting Process (2L)
- From recording of a business transaction to preparation of trial balance including adjustments
- c) Computerized Accounting Systems (15L)
- Computerized Accounting Systems: Computerized Accounts by using any popular accounting software: Creating a Company; Configure and Features settings; Creating Accounting Ledgers and Groups; Creating Stock Items and Groups; Vouchers Entry; Generating Reports - Cash Book, Ledger Accounts, Trial Balance, Profit and Loss Account,

Balance Sheet, Funds Flow Statement, Cash Flow Statement Selecting and shutting a Company; Backup and Restore data of a Company

Unit II:

- a) Business Income (10 L)
- i. Measurement of business income-Net income: the accounting period, the continuity doctrine and matching concept. Objectives of measurement.
 - ii. Revenue recognition: Recognition of expenses.
 - iii. The nature of depreciation. The accounting concept of depreciation. Factors in the measurement of depreciation. Methods of computing depreciation: straight line method and diminishing balance method; Disposal of depreciable assets-change of method. iv. Inventories: Meaning. Significance of inventory valuation. Inventory Record Systems: periodic and perpetual. Methods: FIFO, LIFO and Weighted Average. Salient features of Indian Accounting Standard (Ind-AS): 2
- b) Final Accounts (6L)
- Capital and revenue expenditures and receipts: general introduction only. Preparation of financial statements of non-corporate business entities.

Unit III: Accounting for Hire Purchase and Installment Systems (10L)
Calculation of interest, partial and full repossession, Hire purchase trading (total cash price basis), stock and debtors system; Concepts of operating and financial lease (theory only)

Unit IV: Accounting for Inland Branches (10L)
Concept of dependent branches; accounting aspects; debtors system, stock and debtors system, branch final accounts system and whole sale basis system. Independent branches: concept-accounting treatment: important adjustment entries and preparation of consolidated profit and loss account and balance sheet.

Unit V: Accounting For Dissolution of the Partnership Firm. (4L)
Accounting of Dissolution of the Partnership Firm Including Insolvency of partners, sale to a limited company and piecemeal distribution

References

1. Robert N Anthony, David Hawkins, Kenneth A. Merchant, *Accounting: Text and Cases*. McGraw-Hill Education, 13th Ed. 2013.
2. Charles T. Horngren and Donna Philbrick, *Introduction to Financial Accounting*, Pearson Education.
3. J.R. Monga, *Financial Accounting: Concepts and Applications*. Mayur Paper Backs, New Delhi.
4. M.C.Shukla, T.S. Grewal and S.C.Gupta. *Advanced Accounts. Vol.-I*. S. Chand & Co., New Delhi.
5. S.N. Maheshwari, and. S. K. Maheshwari. *Financial Accounting*. Vikas Publishing House, New Delhi.
6. Deepak Sehgal. *Financial Accounting*. Vikas Publishing H House, New Delhi.
7. Bhushan Kumar Goyal and HN Tiwari, *Financial Accounting*, International Book House
8. Goldwin, Alderman and Sanyal, *Financial Accounting*, Cengage Learning.
9. Tulsian, P.C. *Financial Accounting*, Pearson Education.
10. *Compendium of Statements and Standards of Accounting*. The Institute of Chartered Accountants of India, New Delhi.

Note: Latest edition of the text books should be used.

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS404.1	Describe, explain, and integrate fundamental concepts underlying accounting, finance, management, marketing, and economics	02
AS404.2	Use information to support business processes and practices, such as problem analysis and decision making	03
AS404.3	Apply quantitative skills to help analyze and solve business problems and to take advantage of business opportunities and explain the ethical and social responsibilities of actuaries in ensuring the integrity of financial information	03
AS404.4	Apply knowledge of generally accepted accounting principles (GAAP) and managerial accounting theories to business organizations, state and local governments, and nonprofit organizations	03
AS404.5	Apply knowledge of tax laws and procedures to individuals and businesses	03

AS-405-Practicals-IV**Course Objectives (COBs):**

- To understand various statistical tools used in studying sampling distribution of different statistics/estimators and their likelihoods.
- To make students aware of sample survey data and its analysis.
- To construct life tables using analytical laws of mortality and mortality patterns and estimate Net single/mthly premiums for different insurance policies.

Detailed Syllabus:

- A. Practicals based on AS-401 (Mathematical Statistics) (15 Hrs)**
1. Sampling distribution of Statistics/ Estimators
 2. Plotting likelihood functions for standard probability distributions.
 3. Unbiased estimation, Moment Estimation, Maximum Likelihood Estimation for parameters and parametric functions.
 4. Plotting power function for the given test and concluding the decision based on the observed data using MP tests.
 5. Practical on one sample location problem: Sign test, Wilcoxon Signed rank test, Kolmogorov-Smirnov test.
- B. Practicals based on AS-402 (Survey Sampling and Indian Official Statistics) (45 Hrs)**
1. Drawing simple random samples from a given finite population using SRSWR and SRSWOR.
 2. Estimating the population total, mean, proportion and the variance of the estimator obtained using the sample drawn.
 3. Minimum sample size requirement under SRSWOR.
 4. Confidence interval for population total, mean and proportion under SRSWOR.
 5. PPS, πps designs and Midzuno design
 6. H-T estimator

7. Stratified Random Sampling: Estimation of population total and mean with S.E.
8. Stratified Random Sampling: Various kinds of allocation and estimation of population total and mean with S.E.
9. Ratio method of estimation
10. Regression method of estimation
11. Cluster sampling
12. Systematic sampling.

C. Practicals based on AS-403 (Life Contingencies-I) (30 Hrs)

1. Construction of life tables and problems based on life tables.
2. Construction of life tables using analytical laws of mortality and mortality patterns.
3. True values and estimation of Net single premiums for different insurance policies.
4. True values and estimation of life annuities.
5. Calculation of yearly and mthly premium values of life insurance.
6. Benefit Reserves

Course Outcomes (COs):

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

CO No.	Course Outcome	Cognitive Level
AS405.1	Use statistical software for studying sampling distribution of Statistics/ Estimators and testing of hypotheses.	03
AS405.2	Visualize data and exploratory data analysis using statistical software like MATLAB, MINITAB and R	03
AS405.3	Compare different estimators and sampling methods when real life data sets are given using statistical software.	04
AS405.4	Construct life tables for different mortality parameters and estimate premiums for life insurance schemes.	03
AS405.5	Calculation of APV for different life annuities and life insurance contracts	03

AS-501-Survival Models

Course Objectives (COs):

- To learn the different statistical distributions of survival models
- To understand censored data and non-parametric techniques for survival estimation
- To learn to fit models to the survival data.

Detailed Syllabus:

- Survival Models (10L)
The distribution and density functions of the random future lifetime, the survival function, the force of mortality or hazard rate and derive relationships between them, Laws of mortality like Gompertz and Makeham, the distribution and density functions of the curtate future lifetime random variable.
- Estimating the lifetime distribution and Proportional hazards models (15L)

Truncation, Right censoring, Left or interval censoring, Likelihood construction for censored and truncated data, Kaplan-Meier model, Nelson Aalen model, Cox proportional hazard model, Breslow’s approximations to the partial likelihood estimator.

- Exposed to risk (3L)
Central and Initial Exposed to risk, concepts of rate intervals and their impact on estimators
- Graduation (12L)
Purpose and methods of graduation, testing goodness of fit and testing smoothness of a set of graduated estimates, statistical test for comparing a set of crude estimates and a standard table or a set of crude estimates and a set of graduated estimates, effect of duplicate policies on estimates.
- Mortality projection (20L)
Forecasting of future mortality rates based on extrapolation, explanation and expectation, and their advantages and disadvantages. Lee-Carter, age-period-cohort, and *p*-spline regression models for forecasting mortality.

References

6. Institute of Actuaries core reading for subject CS2.
7. Klein J.P. and Moeschberger, M.L.(2003) Survival Analysis: Techniques for Censored and Truncated Data 2nd Edition, Springer Verlag, New York,.
8. Klugman, S.A.(June 2003), "Estimation, Evaluation, and Selection of Actuarial Models".
9. Dick London (1997), Survival Models and their Estimation, second edition, ACTEX publications.
10. Cox, D.R. and Oakes, D.(1984) Analysis of Survival Data, Chapman and Hall, New York.

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS501.1	Understand various statistical methods and Data Analysis techniques for Survival models.	02
AS501.2	Estimate transition probabilities or intensities depending on age, exactly or using the census approximation.	02
AS501.3	Apply parametric and non-parametric methods for estimation of survival Function.	03
AS501.4	Test crude estimates for consistency with a standard table or a set of graduated estimates and describe the process of graduation.	04

AS-502-Applied Statistics

Course Objectives (CObs):

- To describe the purpose of exploratory data analysis.
- To describe, apply and interpret the results of the linear regression model and generalised linear models.

- To study concepts underlying time series models.
- To study basic principles of machine learning.

Detailed Syllabus:

- Data analysis (6L)
Exploratory data analysis; Describe the purpose of exploratory data analysis, use appropriate tools to calculate suitable summary statistics and undertake exploratory data visualizations, define and calculate Pearson's, Spearman's and Kendall's measures of correlation for bivariate data, use Principal Components Analysis to reduce the dimensionality of a complex data set.
- Linear regression (14L)
Simple linear regression model, least-squares estimation of parameters, fitting of simple linear regression model, statistical inference on parameters, measures of goodness of fit, estimation of mean response, checking the model.
Multiple linear regression model, fitting of multiple linear regression model, hypothesis testing in multiple linear regression model, checking the model, process of selecting explanatory variables.
- Generalised linear model (GLM) (10L)
Generalised linear models, exponential family of distributions, Link function, Canonical link function, Linear Predictors, Model fitting and comparison, Deviance of model fitting, scaled deviance, Residuals analysis and assessment of model fit.
- Time Series Analysis (20L)
Concepts underlying Time series models; concept and general properties of stationary, univariate time series, concept of stationary random series, concept and basic properties of autoregressive (AR), moving average (MA), autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) time series, applications of time series models.
Compensating for trend and seasonality, identification of $MA(q)$ and $AR(p)$ models, fitting of time series model using Box-Jenkins methodology, forecasting, Multivariate time series models.
- Machine learning (10L)
Explain and apply elementary principles of machine learning, supervised and unsupervised machine learning techniques, explaining the difference between regression and classification and between generative and discriminative models, explain in detail and use appropriate software to apply machine learning techniques (*eg.* penalised regression and decision trees) to simple problems.

References

1. Institute of Actuaries core reading for subject CS1.
2. Montgomery D.C, Peck, E.A and Vining G.G(2003). Introduction to Linear Regression Analysis, (3rd Ed. Wiley)
3. Montgomery, D.C. Johnson L.A (1977) Forecasting and Time Series Analysis, McGrawHill.
4. Brockwell, P.J. and Davis R.A. Time Series: Theory and Methods (Second Edition) Springer-Verlag.
5. Gupta S.C. & Kapoor V.K.: Fundamentals of Applied Statistics, S. Chand Sons, New Delhi

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS501.1	Summarise data using appropriate tools of exploratory data analysis	05
AS501.2	Apply the main concepts underlying the analysis of linear regression model, generalised linear models and time series models.	03
AS501.3	Apply statistical tests to determine the acceptability of a fitted model	03
AS501.4	Describe and apply elementary principles of machine learning	03

AS-503-Finance and Financial Reporting**Course Objectives (CObs):**

- to provide a basic understanding of corporate finance including a knowledge of the instruments used by companies to raise finance and manage financial risk.
- to provide the ability to interpret the accounts and financial statements of companies and financial institutions.
- To demonstrate a knowledge and understanding of the principal terms in use in investment and asset management.

Detailed Syllabus:

- Principal terms in investment and asset management. (6L)
- Key principles of finance. (6L)
- Structure of Joint Stock Company and the different methods of financing by which it may be financed. (6L)
- Basic principle of personal and corporate taxation. (6L)
- The characteristics of principal forms of financial instrument used by companies. (6L)
- Factors to be considered by a company when deciding on its capital structure and dividend policy. (6L)
- Definition of company's cost of capital & the nature of the investment projects. (6L)
- The basic construction of accounts of different types and principal features of the accounts of a company. (6L)
- Interpretation of the accounts of a company or a group of companies and limitations of such interpretation. (6L)
- Financial techniques used in the assessment of capital investment projects. (6L)

Note: Teacher may relate above topics with the syllabus of CB1 and CB3 of IAI.

References

1. Brigham, Eugene F and Houston, Joel F., Fundamentals of financial management. 9th ed. Harcourt Brace, 2000 ISBN 0030314615.

2. Holmes, Geoffrey and Sugden, Alan, Interpreting company reports and accounts. 7th ed. Prentice hall, 1999 ISBN 027364615X.
3. Samuels, J.M; Wikes, F.M; Bray Shaw, R.E, Management of company finance. 6th ed. International Thomson, 1995 ISBN 1861522290.
4. Brealey, Richard A and Myers, Stewart C., Principles of corporate finance. 6th ed. McGraw-Hill, 1999 ISBN 0077095650.
5. Brett, How to read the financial pages. M. 2nd ed. Random House Business Books, 2003. ISBN:0712662596

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS501.1	Describe the basic principles of personal and corporate taxation.	02
AS501.2	Discuss the factors to be considered by a company when deciding on its capital structure and dividend policy.	02
AS501.3	Describe the major types of financial institution operating in the financial markets.	02
AS501.4	Describe the basic construction of accounts of different types and the role and principal features of the accounts of a company.	02

AS-504-Life Contingencies-II

Course Objectives (COs):

- To explain simple annuity and assurance contracts.
- To develop the formulae for the mean and variances of the Present values of payments under this contracts.
- To summarize the practical methods of evaluating expected values and variances of the simple contracts.
- To describe the Net premium and Net premium reserve of simple insurance contracts by using ultimate or select mortality.

Detailed Syllabus:

- **Insurance Models Including Expenses** (8L)
List the type of expenses incurred in writing a life insurance contract, Describe the influence of inflation on the expenses, Define the gross future loss random variable for the benefits and annuities using equivalence principle.
- **Multiple Life Functions** (8L)
Joint distribution of Future Lifetimes, The Joint-Life Status, The Last-Survivor Status, More Probabilities and Expectations, Dependent Lifetime Models: Common Shock, Insurance and Annuity Benefits: Survival Status, Special Two-Life Annuities, Reversionary Annuities, Simple Contingent Functions.

- **Multiple Decrement Model** (12L)
Two random variables, Random Survivorship Group, Deterministic Survivorship Group, Associated single Decrement tables: Basic Relationship, Uniform Distribution Assumption for multiple decrements, Construction of Multiple decrement table, Relationship between single and multiple decrement tables.
- **Application of multiple decrement theory** (12L)
Actuarial present value and their numerical evaluation, benefit premium and reserves, competing risks, multiple state modelling, multiple state Markov model, Kolmogorov forward equations, multiple decrement tables.
- **Profit testing** (12L)
Discounted emerging costs, unit-linked contract, Profit test annual premium contracts, the profit vector, the profit signature, the net present value and the profit margin, determining premiums using profit test, Profit criterion, determining reserves using profit testing, Zeroising negative cashflows, Equity-linked insurance, deterministic profit testing for equity linked insurance, Stochastic profit testing, Stochastic pricing, Stochastic reserving.
- **Pension funds** (8L)
Multiple decrement service table for pensions calculations, updating a service table, the salary scale function, setting the DC contribution, the service table, funding plans, valuation of benefits: Final salary plans, Career average earnings plans.

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS504.1	Understand the assurance and annuity contracts.	2
AS504.2	Calculate the expressions in the form of sums/integrals for the mean and variances of the present value of benefit payments of annuity/assurance contracts.	3
AS504.3	Develop insurance contracts.	3
AS504.4	Identify net premium and net premium reserve for the conventional with-profits contracts.	4

AS-505-Practicals-V

Course Objectives (COs):

- To understand various statistical tools used in exploratory data analysis
- To fit simple linear regression, multiple linear regression, generalised models and main linear Time series models to data sets.
- To obtain mean and variances for the different types of assurance contracts.
- To obtain multiple decrement table

Detailed Syllabus:

- A. Practicals based on AS-501 (Survival Models) (30 Hrs)**
1. Plotting of utility functions.
 2. Life table using analytical laws of mortality.
 3. Estimation of the empirical survival functions in the absence of censoring.
 4. Kaplan-Meier (or product limit) estimate and Nelson-Aalen estimate of the survival function in the presence of censoring.
 5. Find the actuarial estimates of Initial and Central Exposed to risk under Binomial and Poisson models of number of deaths observed.
 6. Test crude estimates for consistency with a standard table or a set of graduated estimates.
 7. Test for smoothness of a set of graduated estimates.
 8. Practicals based on Mortality projections
- B. Practicals based on AS-502 (Applied Statistics) (30 Hrs)**
1. Exploratory data analysis
 2. Simple linear regression
 3. Multiple linear regression
 4. Generalised linear model
 5. Time Series Analysis
 6. Machine learning
- C. Practicals based on AS-504 (Life Contingencies-II) (30 Hrs)**
1. Gross premium
 2. Dependent Lifetime Models
 3. Multiple Decrement Models.
 4. Actuarial present value in Multiple Decrement Models.
 5. Profit testing.
 6. Pension funds.

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS505.1	Analyze appropriate tools used in exploratory data analysis	4
AS505.2	Use appropriate statistical software to fit linear regression model, generalized linear models and Time series models to data set and interpret the output	3
AS505.3	Calculate mean and variances for the any type of Insurance/annuity contracts.	3
AS505.4	Calculate multiple decrement table by using multiple decrement probabilities.	3

AS-601-Stochastic Modeling

Course Objectives (CObs):

- To study of the basic concepts of the theory of deterministic and stochastic modelling
- Study of various properties and characteristics of stochastic models
- Study of the methods for describing and analysing complex stochastic models.

Detailed Syllabus:

- Stochastic processes (4L)
Types of Stochastic processes, sample path, white noise, random walk, strictly stationary and weakly stationary processes, increments, Markov property of stochastic processes, Poisson process, Compound Poisson process.
- Markov chains (14L)
Definitions, finite and countable state space Markov chains, Chapman-Kolmogorov equations, limiting and stationary distribution of Markov chains, classification of states, periodicity, transient and recurrent Markov chain and related results, first passage time, two state Markov model, Time homogenous and time inhomogeneous Markov processes, Long term behaviour of Markov chain, estimation of transition probabilities.
- Time homogenous Markov jump processes (14L)
Poisson process, Sums of Poisson process, distribution of the number of events in given time interval, inter arrival times, holding times and waiting times distributions, occupancy probabilities, applications of these results, Kolmogorov forward and backward differential equations for a Markov process with time independent transition intensities, maximum likelihood estimator in general model.
- Time-inhomogeneous Markov jump processes (14L)
Chapman Kolmogorov equations, transition rates, Kolmogorov forward and backward equations for a Markov process with time dependent transition intensities, integrated form of Kolmogorov forward and backward equations, simple survival models, sickness models and marriage models in terms of Markov processes and other simple applications.
- Brownian motion and Stochastic Models for security prices (14L)
Basic properties of standard Brownian motion or Wiener process, stochastic differential equations, the Ito integral, diffusion and mean-reverting processes, stochastic differential equation for geometric Brownian motion and Ornstein-Uhlenbeck process. Stochastic differential equations, the Ito integral, diffusion and mean-reverting processes, continuous-time lognormal model of security prices

References

1. Institute of Actuaries core reading for subject CS2.
2. Ross, S. (2005) Introduction to Probability Models (6th Ed. Academic Press).
3. Medhi, J. (1994). Stochastic Processes, (2nd Ed. New Age Publisher).
4. Brzezniak, Zdzislaw and Zastawniak, Tomasz, (1999) Basic stochastic processes: A course through exercises. (Springer)
5. Grimmett, Geoffrey and Stirzaker, David (2001) Probability and random processes.(3rd ed. Oxford University Press).

6. Grimmett, Geoffrey and Stirzaker, David(2001), One thousand exercises in Probability.(2nd ed. Oxford University Press).
7. Norris (1997), Markov Chains. (Cambridge Uni Press).

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS601.1	Apply the deterministic and stochastic models for range of applications.	3
AS601.2	Demonstrate essential stochastic modelling tools including Markov chains and queuing theory.	2
AS601.3	Formulate and solve problems which involve setting up stochastic models.	6

AS-602-Total Quality Management and Statistical Process Control

Course Objectives (CObs):

- To describe the concept of variation, TQM tools and role of statistics in Quality Improvement through SPC tools.
- To make aware the students about the Industrial production processes and applications of SPC tools for monitoring those processes.
- To prepare students to carry out process capability analysis based on real life process data.

Detailed Syllabus:

- Total Quality Management. (12L)
 - Concept of Quality, Quality improvement, Quality philosophy.
 - Introduction of TQM, evaluation of Total Quality.
 - Some important TQM concepts.
 - TQM Gurus' Ideas.
 - Japanese 5-S Practice.
 - Importance of team work
 - The Impact of National and International Quality Awards on TQM.
 - The European Quality Award.
 - The Deming Application Prize.
 - Six Sigma and other Extensions of TQM.
 - Quality systems.
 - The ISO 9000 and other Quality systems.
- Some Statistical methods useful in Quality Improvement. (5L)
 - Concept of variation, systematic variation, random variation, stable industrial processes.
 - Describing variation through graphical and numerical methods.
 - Some important Discrete and continuous probability distributions useful in quality control and improvement.
 - Some useful approximations of Distributions.

- Statistical Process Control (SPC).
 - Introduction of SPC. (5L)
 - Basic concept of process monitoring and control.
 - Seven tools of SPC.
 - General theory of Control charts.
 - Different types of limits, Specification limits, Natural tolerance limits, Control limits, Warning limits.
 - OC Curve and ARL of control charts.
 - Control Charts for Attributes. (8L)
 - Control chart for fraction nonconforming.
 - Control chart for fraction nonconformities (defects)
 - OC Curves for Attributes control charts.
 - Control Charts for Variables. (8L)
 - Statistical basis of the charts for variables.
 - \bar{X} , R , S , \bar{X} and R , \bar{X} and S , \bar{X} and S^2 Control Charts.
 - Median chart and Midrange chart.
 - Control charts for Individual Measurements.
 - Special control charts: CUSUM, EWMA control charts.
 - Process Capability Analysis. (10L)
 - Capable process and Process capability.
 - Process Capability Analysis using Histogram or Probability plot.
 - Process Capability indices under normal distribution of quality characteristic.
 - Capability indices C_p , C_{pk} , C_{pm} .
 - Connection between proportion of nonconforming and C_p , C_{pk} .
 - Estimation, C.I. and tests of hypotheses relating to C_p .
 - Process Capability Analysis for non-normal data.
 - Process Capability Analysis for Designed Experiments.
 - Gauge and Measurement system capability studies.
 - Setting specification limits on discrete components, linear and nonlinear combinations.
 - Estimating the Natural tolerance limits of a process.
 - Acceptance Sampling. (12L)
 - Single, double and sequential sampling plans for attributes and their properties.
 - Curtailed double sampling plans, operating characteristics functions and other properties of the sampling plans.
 - Sampling plans with rectification. OC, ASN, ATI, AOQ curves, AOQL, Designing of sampling plan. Dodge-Romig acceptance sampling plans.
 - Plan for inspection by variables for one-sided and two-sided specifications; AQL based sampling plans.

References

1. Besterfield, D.H., Besterfield-Michana, c., Besterfield, G.H., Besterfield-Sacre, M. Total Quality Management; Pearson Education(Singapore) Pte. Ltd. India. 2nd Edition 2001.
2. Caulcutt, Roland. Achieving Quality Improvement (A practical guide); Chapman and Hall, UK. 1st Edition 1995.
3. Montgomery, D.C. (2009) Introduction to Statistical Quality Control; Wiley, 6th Edition.

4. Wadsworth H.M.; Stephens K.S. and Godfrey A.B. Modern Methods for Quality Control and Improvement ,2nd Ed. Wiley.
5. Ho, Samuel K. TQM An Integrated Approach; Crest Publishing House, New Delhi. 1st Indian Edition 2002.
6. Wetherill, G.B. and Brown, D.W. Statistical Process Control, Theory and Practice; Chapman and Hall.
7. Logothetis, N.(1992). Managing Total Quality; Prentice Hall of India.
8. Oakland J.S. (1989). Total Quality Management; Butterworth-Heinemann.

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS602.1	Describe the concept of variation, Quality, TQM tools and terminologies useful as per standards of ISO.	2
AS602.2	Describe and apply SPC tools useful for Quality control and Quality improvement.	2
AS602.3	Apply different graphical tools useful in SPC and interpret their uses.	3

AS-603-Credibility Theory & Loss Distributions

Course Objectives (CObs):

- To explain the concepts of Decision Theory and apply them.
- To describe probabilities and moments of loss distributions both with and without limits and risk-sharing arrangements.
- To develop and construct Risk models involving frequency and severity distributions and calculate moment generating function and the moments for the risk models both with and without simple reinsurance arrangements.
- To Explain the fundamental concepts of Bayesian statistics and use these concepts to calculate Bayesian estimators.

Detailed Syllabus:

- Loss distributions (15L)
Review of Statistical distributions suitable for modelling individual and aggregate losses including the gamma, exponential, Pareto, generalised Pareto, normal, lognormal, Weibull and Burr distributions , concepts of excesses (deductibles), and retention limits, operation of simple forms of proportional and excess of loss reinsurance, Estimation of the parameters of a failure time or loss distribution when the data is complete, or when it is incomplete, using maximum likelihood and the method of moments.
- Extreme value distributions (10L)
Extreme Value distributions suitable for modelling the distribution of severity of loss and their relationships, various measures of tail weight and interpret the results to compare the tail weights.

- Copulas (5L)
Dependence or concordance, upper and lower tail dependence the form and characteristics of the Gaussian copula and the Archimedean family of copulas.
- Risk models (14L)
Reinsurance, Short term insurance contracts, compound Poisson distribution, compound binomial, compound negative binomial random variables, simple forms of proportional and excess of loss reinsurance for insurer and reinsurer.
- Credibility theory and Empirical Bayes Credibility theory (16L)
Credibility, Credibility premium formula, credibility factor, Poisson/gamma model, normal/normal model, Bayes’ Theorem, prior distribution, a posterior distribution and a conjugate prior distribution, loss function, Empirical Bayes approach to credibility theory, Calculation of credibility premium.

References

1. Institute of Actuaries core reading for subject CS2.
2. Loss Models: From Data to Decisions, 3rd Edition Stuart A. Klugman (Drake Univ., IA), Harry H. Panjer (Univ. of Waterloo, Canada), Gordon E. Willmot (Univ. of Waterloo, Canada) ISBN: 978-0-470-18781-4

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS603.1	Determine the Optimum strategies under the theory of games.	3
AS603.2	apply the principles of statistical inference to select loss distributions for sets of claims.	3
AS603.3	construct the models appropriate models for short term insurance contracts in terms of numbers of claim and the amounts of individual claims.	3
AS603.4	apply Bayesian approach to credibility theory and use it to derive credibility premiums in simple cases.	3

AS-604-Financial Economics

Course Objectives (COs):

- To develop the necessary skills to construct asset liability models and to value financial derivatives.
- To compare investment opportunities using commonly used utility functions, modern portfolio theory, stochastic modelling, investment risks, single and multifactor models.
- To critically evaluate modern financial theories.

Detailed Syllabus:

- Efficient Markets Hypothesis(EMH) (5L)
Three forms of the Efficient Markets Hypothesis and their consequences for investment management, evidence for or against each form of the Efficient Markets Hypothesis

- Utility theory (5L)
Applications of utility theory to financial problems, expected utility theorem, riskaversion, risk neutrality and risk seeking, concept of utility maximization and hence explain the traditional theory of consumer choice, conditions for absolute dominance and for first and second-order dominance and their relationship with utility theory
- Mean-Variance Portfolio theory (15L)
Measures of investment risk, Variance of return, downside semi-variance of return,shortfall probabilities, Value at Risk (VaR) / Tail VaR, Diversification and its benefits,Calculation of the expected return and risk of a portfolio of many risky assets, giventhe expected return, variance and covariance of returns of the individual assets, using mean-variance portfolio theory.
- Single and multifactor models (5L)
Single and multifactor models, types of multifactor models of asset returns, singleindex model of asset returns, diversifiable and non-diversifiable risk
- Asset pricing models (5L)
Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM), Ross Arbitrage PricingTheory model (APT)
- Simple models for credit risk (5L)
Credit event and recovery rate, Merton model, two-state model for credit ratings witha constant transition intensity, Jarrow-Lando-Turnbull model for credit ratings.
- Run-off triangles (10L)
The origins of run-off triangles, Presentation of claims data, basic chain ladder method, average cost per claim method and Bornhuetter-Ferguson method for estimating outstanding claim amounts.
- Ruin Theory (10L)
Introduction, aggregate claim process and the cash-flow process for a risk, surplus process, probability of ruin in infinite/finite and continuous/discrete time and relationship between them, distribution of arrival, interarrival and waiting time in Poisson process, Compound Poisson process, Lundberg's inequality, Analysis of the effect on the adjustment coefficient and hence on the probability of ruin of simple reinsurance arrangements

References

1. Institute of Actuaries core reading for subject CM2.
2. Anderson, Sweeney, Williams. Statistics for Business and Economics, Thomson Publication 8th Edition.
3. Hall John C. Options, Futures and Other derivatives 5th edition, Prentice hall, 2002
4. Oksendal B. Stochastic Differential Equation, An Introduction with applications Springer, 2003.
5. Teresa Bradley and Paul Patton. Essential Mathematics for Economics and Business (Second Edition) Wiley India Pvt. Ltd.

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS604.1	Describe and discuss the application of utility theory to economic and financial problems.	2
AS604.2	Describe and discuss the assumptions of mean-variance portfolio theory and its principal results, properties of single and multifactor models of asset returns.	2
AS604.3	Describe and apply techniques for analysing a delay (or run-off) triangle and projecting the ultimate position	2
AS604.4	Apply the main concepts of Brownian motion (or Wiener Processes) and understanding of stochastic models of the behaviour of security prices.	3

AS-605-Practicals-VI**Course Objectives (COs):**

- To teach SPC tools through statistical software.
- To calculate credibility factor and premium.
- To estimate proportional and excess of loss reinsurance for insurer and reinsurer.
- To estimate parameters for single and multifactor models.
- To develop utility functions to determine good investment opportunities.

Detailed Syllabus:**A. Practicals based on AS-601 (Stochastic Modelling)****(22 Hrs)**

1. Calculation of n-step transition probabilities and limiting distribution in Markov chain.
2. Realization of Markov chain.
3. Simulation of Random Walk.
4. Simulation of Poisson process.
5. Simulation of Brownian Motion
6. Estimation of transition probability of Markov chain using realization.
7. Testing and Estimation of transition probability of Markov chain using realization
8. Stochastic models of the behavior of security prices.
9. Black-Scholes derivative-pricing model.

B. Practicals based on AS-602 (TQM and SPC)**(23Hrs)**

1. Graphical tools used in SPC with their interpretations: Stem-and-leaf plot, Box plot, Histogram, Probability Plots, cause and effect diagram, Pareto chart, Scatter plot, Check sheet, Control chart.
2. Accessing normality of data
3. Identification of probability distribution of quality characteristics.
4. Plotting and interpretation of Control chart for attribute.
5. Plotting and interpretation of Control chart for variable.
6. Process capability analysis for normal and non-normal data.
7. Gauge capability analysis.
8. Single and double sampling plans for attributes: plotting OC, ASN, ATI, AOQ curves, finding AOQL.

9. Single sampling plan for variables.
- C. Practicals based on AS-603 (Credibility Theory & Loss Distributions) (23 Hrs)**
1. Loss distributions and fitting of loss distributions.
 2. Estimation of parametric functions of loss distributions.
 3. Short term insurance contracts.
 4. Estimation of proportional and excess of loss reinsurance for insurer and reinsurer.
 5. Estimation of probability of ruin in infinite/finite and continuous/discrete time.
 6. Computation of posterior probabilities based on simulation.
 7. Calculation of credibility premium
 8. Practicals based on Extreme value distributions
 9. Practicals based on Copula
- D. Practicals based on AS-604 (Financial Economics) (22 Hrs)**
1. Estimate the investment risks using variance of return, downside semi-variance of return, shortfall probabilities, Value at Risk (VaR) / Tail VaR.
 2. Estimating parameters for Single and Multifactor Models.
 3. Estimating parameters for Asset Pricing Models, Capital Asset Pricing Models.
 4. Practicals based Ruin theory
 5. Practicals Run-off triangles

Course Outcomes (COs):

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

Course Outcome	Course Outcome	Cognitive Level
AS605.1	Apply different SPC tools to analyze Industrial production data.	3
AS605.2	Evaluate data and calculate the credibility factor and credibility premium for the given data.	4
AS605.3	Calculate mean and variance for proportional and Non-proportional reinsurance and can also calculate the excess of loss for insurer and reinsurer.	4
AS605.4	Calculate the expected return and risk of portfolios of many risky assets, by applying asset pricing models and capital asset pricing models.	4
AS605.5	Apply utility functions compare the investment opportunities.	3