DEPARTMENT OF ACTUARIAL SCIENCE

SCHOOL OF MATHEMATICAL SCIENCES

NORTH MAHARASHTRA UNIVERSITY

JALGAON-425001, INDIA

SYLLABUS
FOR

S.Y.B.Sc. (Actuarial Science)

Under

the course

B.Sc. (Actuarial Science)

WITH EFFECT FROM ACADEMIC

YEAR 2011-2012

Department of Statistics
School of Mathematical Sciences
North Maharashtra University, Jalgaon

Syllabus Structure for S.Y.B.Sc. (Actuarial Science)

Under

the course
B.Sc. (Actuarial Science)

Semester-I

Course Code	Title of the Course	Contact hours/week			Distribution of Marks for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-301	Calculus-III	03	--	03	40	--	60	--	100	--	04
AS-302	Probability Distributions-II	03	--	03	40	--	60	--	100	--	04
AS-303	Financial Mathematics-I	03	--	03	40	--	60	--	100	--	04
AS-304	Probability Theory	03	--	03	40	--	60	--	100	--	04
AS-305	Financial Accounting	03	--	03	40	--	60	--	100	--	04
AS-306	Practicals-III	--	04	04	--	40	--	60	--	100	04

Semester-II

Course Code	Title of the Course	Contact hours / week			Distribution of Marks for Examination						Credits
					Internal		External		Total		
		Th(L)	Pr	Total	Th	Pr	Th	Pr	Th	Pr	
AS-401	Introduction to Mathematical Statistics	03	--	03	40	--	60	--	100	--	04
AS-402	Sampling Theory of Surveys	03	--	03	40	--	60	--	100	--	04
AS-403	Financial Mathematics-II	03	--	03	40	--	60	--	100	--	04
AS-404	Life Contingencies-I	03	--	03	40	--	60	--	100	--	04
AS-405	Programming in C++ and Numerical Methods	03	--	03	40	--	60	--	100	--	04
AS-406	Practicals-IV	--	04	04	--	40	--	60	--	100	04

Note: Syllabus structure of the course B.Sc. (Actuarial Science) is given separately.

Examination and Declaration of result: Internal and External Examinations will be conducted by the Department of Statistics under Academic flexibility and results will be declared by University's Examination section based on CGPA system.

Detailed Syllabi for S.Y.B.Sc.(Actuarial Science)

AS-301 Calculus-III

- Review of vectors, cross and dot products, lines, planes.   (5L)
- Limit, continuity and Differentiation:
  Functions of several variables, limits and continuity, Partial derivatives, Chain Rule, Directional derivative, Implicit function, Extrema of function of several variables, Lagrange multipliers, Applications.   (18L)
- Multiple integrals:
  Double integrals, Iterated integrals, Double integrals in polar coordinates, Area, Volume, Triple integrals, Triple integrals in cylindrical and spherical coordinates, Change of variables, Jacobians.   (10L)
- Vector Calculus:
  Vector fields, Line integrals, Independence of path, Green's theorem, Curl and divergence, Surface integrals, Divergence theorem, Stokes' theorem.   (12L)

References
1. Adams, Robert R., Calculus: A complete course.
2. Narayan, Shanti, Vector Calculus, S. Chand and company, New Delhi.
3. Widder, David, Advanced Calculus, Prentice Hall of India, New Delhi.

AS-302 Probability Distributions-II

- Review of discrete random variable and discrete probability distributions.   (5L)
- Continuous random variable, probability density function and cumulative distribution function and cumulative distribution functions of continuous random variables.   (3L)
- 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.(12L)
- Other univariate continuous probability distribution: lognormal, Weibull, Laplace, Beta distributions.   (12L)
- Relation between different distributions.   (5L)
- 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.   (7L)
- Joint distribution of random variables, marginal, conditional distribution, conditional expectations etc.

References
1. Rohatgi V.K. and Ehsanes Saleh A. K. MD. (2003). An Introduction to Probability Theory and Mathematical Statistics, (Wiley Eastern, 2nd Ed.).
2. Hogg, R.V. and Craig, A.T. (1978). Introduction to Mathematical Statistics, (5th Ed. Pearson Education).
3. Hogg, R.V. and Tanis E.(2002) An. Probability and Statistical Inference (6th Ed. Pearson Education).

AS-303 Financial Mathematics-I

- 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 putable bonds, Serial bonds, some generalizations, other securities, Valuation of securities.

References
1. Kellison Stephen G., The Theory of Interest, 3rd Edition. McGraw-Hill International Edition (2009).
2. UK Institute of Actuaries core leading for the subject CT1-Financial Mathematics.
3. Elliott R.J. and Kopp P.E. Mathematics of Financial Markets. Springer.1999

AS-304 Probability Theory

- Sets and Classes of Events   (6L)
- Random Variables   (6L)
- Measure and Probability Measure   (6L)
- Distribution Functions   (4L)
- Expectation and Moments   (7L)
- Convergence of Sequence of Random variables   (7L)

- Characteristic function   (2L)
- Independence   (3L)
- Law of large numbers   (2L)
- Central limit theorem (CLT):   (2L)

References

1. Ash, Robert. (1972). Real Analysis and Probability, (Academic Press).
2. Bhat, B.R. (1999). Modern Probability Theory, (3rd Ed. New Age Inter-national (P) Ltd.Publication)
3. Billingsley, P. (1986).Probability and Measure, (Wiley).
4. Dudley, R. M. (1989).Real Analysis and Probability, (Wadsworth and Brook/Cole).
5. Kingman, J.F.C. and Taylor, S.J. (1966). Introduction to Measure and Probability, (Cambridge University Press).
6. Basu, A. K. (1999). Measure Theory and Probability (Prentice Hall of India).

AS-305 Financial Accounting

- Role of financial accounting in business organization.   (3L)
- Accounting Process: From recording of transactions to preparation of final accounts(7L)
- Journal entries, Ledger account, and trial balance.   (18L)
- Financial Statement Analysis.   (5L)
- Final Accounts of a Sole-Trader.   (5L)
- Statement of Cash Flows and fund flows.   (5L)
- Financial accounting Vs "other" accountings.   (2L)

References

1. Mukharjee, Hanif A.M. Financial accounting. (TATA McGraw-Hill)
2. T.S, Grewal, Introduction to Accounting, S. Chand and Co., New Delhi
3. B.K. Goyal, Financial Accounting, Modern Publications, New Delhi.
4. Nirmal Gupta, Financial Accounting, Sahitya Bhavan Publishers and Distributers (Pvt), Ltd.
5. Narender Kumar and Naseem Ahmad. Financial Accounting.
6. P. Periasamy. A textbook of financial cost and management accounting. (Himalaya Publishing house)

AS-306 Practicals- III (On PC Using Software)

A.   Practicals based on AS-301 (Calculus-III)   (8 Hrs)

1. Approximation for the function of two and three variables.
2. To find the extreme values of a function of two or more variables.
3. Line integral and double integration of a function.
4. Tipple integration of a function.

B.   Practicals based on AS-302 (Probability Distribution-II)   (16 Hrs)

1. Plotting of PDF and CDF of a continuous random variable.
2. Generating random sample from given continuous distribution.
3. Generating random sample from standard distributions such as Normal, Uniform Gamma, exponential etc.
4. Generating random sample from joint and conditional distribution.
5. Computing various functions of sample observations based on random samples drawn from any continuous distribution.

C.   Practicals based on AS-303 (Financial Mathematics I)   (20 Hrs)

1. Calculation 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. Redemption of loan schedule.
5. Bonds and securities.

D.   Practicals based on AS-304 (Probability Theory)   (6Hrs)

1. Plotting c.d.f.
2. Applications and verification WLLN.
3. Applications and verification of CLT.

E.   Practicals based on AS-305   (8Hrs)

1. Balance sheets.
2. Trials, journals and ledgers.
3. Analysis of financial statements.
4. Cash flows and fund flows.

AS-401 Introduction to Mathematical Statistics

- Bivariate and Multivariate Probability Distribution, Marginal and Conditional Probability Distribution, Independent Random Variables, Covariance and other expectations, The Bivariate Normal Distribution.   (7L)
- 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.   (7L)
- Sampling distributions, the derivation of the chi-square, t, and F distributions, revisit the central limit theorem and derive the distribution of the sample variance.   (5L)
- Estimation: unbiasedness, mean square error, evaluation of point estimators, Confidence interval estimation for the difference between two population parameters, confidence interval estimation for the population variance.   (6L)

- 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.   (6L)
- Developing formal hypothesis tests using discrete and continuous   distribution theory, Type I and Type II errors, power of a test and the Neyman-Pearson Lemma, P-values, uniformly most powerful tests, likelihood ratio tests.   (7L)
- Simple Linear Regression Analysis: Least squares estimation, inference for estimated coefficients, prediction, model assessment, correlation and the coefficient of determination.   (7L)

References

1. Wackerly, D.D., Mendenhall, W.M., and Scheaffer, R.L., Mathematical Statistics, Sixth Edition. Duxbury press.
2. Rohatgi V.K. and Ehsanes Saleh A. K. MD. (2003). An Introduction to Probability Theory and Mathematical Statistics, (Wiley Eastern, 2nd Ed.).
3. Hogg, R.V. and Craig, A.T. (1978). Introduction to Mathematical Statistics, (5th Ed. Pearsons Education).
4. Hogg, R.V. and Tanis E.(2002) An. Probability and Statistical Inference (6th Ed. Pearsons Education).

AS-402 Sampling Theory of Surveys

- Simple random sampling, estimators of associated parameters and their properties, Extension to sampling for proportions and percentages.   (8L)
- 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, π*ps* design.   (8L)
- Stratified random sampling, estimators of associated parameters and their properties, Extension to sampling for proportions and percentages.   (8L)
- Ratio estimator, bias and variance of ratio estimator, sample estimation of variance of ratio estimate, Comparison with mean per unit estimator.   (6L)
- Regression estimators, two types of regression estimators, bias and variance of regression estimators, sample estimation of variance of regression estimator, Comparison with other estimators.   (6L)
- Systematic sampling, comparison with stratified random sampling, problems of linear trend, and/ or periodic variations, Variance of the estimated mean and sample estimate thereof.   (5L)
- Randomized response technique, Warner's model; related and unrelated questionnaire methods.   (4L)

References

1. Cochran, W.G. (1984). Sampling Techniques, (Wiley).
2. Des Raj and Chandok (1999). Sample Survey Theory, (Narosa).
3. Sukhatme, P.V, Sukhatme, B.V and Ashok C. (1984). Sampling Theory of Surveys with Applications, (Iowa State University Press & IARS).
4. Mukhopadhay P. (2002). Theory and Method of Sample Survey, (Chapman and Hall).

AS-403 Financial Mathematics-II

- 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.
- Practical applications: (7L)
  Introduction, Truth in lending, Automobile financing, Real estate mortgages, Approximate methods, Depreciation methods, Capitalized cost, Modern financial instruments.
- More advanced financial analysis: (8L)
  Introduction, An economic rationale for interest, Determinants of the level of interest rates, Recognition of inflation, Consideration of expenses, Effect of taxes, Currency exchange rates, Reflecting risk and uncertainty, Interest rate assumptions.
- The term structure of interest rates: (8L)
  Introduction, Yield curves, Spot rates, Relationship with bond yields, Forward rates, Arbitrage, A continuous model.
- Duration, convexity and immunization: (6L)
  Introduction, Duration, Convexity, Interest sensitive cash flows, Analysis of portfolios, Matching assets and liabilities, Immunization, Full immunization, A more general model.
- Stochastic approaches to interest: (8L)
  Introduction, Independent rates of interest, The lognormal model, Time series models, Binomial lattices, Continuous stochastic models, Scenario testing, More advanced models.

References

1. Kellison Stephen G., The Theory of Interest, 3rd Edition. McGraw-Hill International Edition(2009).
2. UK Institute of Actuaries core leading for the subject CT1-Financial Mathematics.
3. Elliott R.J. and Kopp P.E. Mathematics of Financial Markets. Springer.1999

AS-404 Life Contingencies I

- Introduction to Life Insurance.   (2L)
- Survival Distributions and Life Tables: (13L)
  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: (15L)
  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: (15L)
  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.

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.

AS-405 Programming in C++ and Numerical Methods

Computer Programming in C++:

- Principles of Object-Oriented Programming.   (3L)
- Beginning with C++.   (3L)
- Tokens, Expressions and Control Structures.   (5L)
- Functions in C++.   (3L)
- Classes and Objects.   (5L)
- Constructors and Destructors.   (4L)
- Operator Overloading and Type Conversions.   (5L)
- Inheritance: Extending Classes.   (3L)
- Pointers, Virtual Functions and Polymorphism.   (3L)

Numerical Methods:

- Errors in Numerical Calculations (2L)
- Iterative methods (3L)
- Interpolation (2L)
- Numerical Integration (4L)

References

1. E. Balagurusamy, (2006). Object-Oriented Programming with C++, (Ed. Tata McGraw Hill).
2. Gottfried. Programming in C++, (Schaum's Outline Series).
3. Venugopal, K. R., Rajkumar, J.Ravishankar. Mastering C++.
4. Rajaraman, V. (1993). Computer Oriented Numerical Methods, (3rd Ed. Prentice-Hall)
5. Press, W. H., Teukolsky, S. A., Vellering, W.T. and Flannery, B.P. (1993). Numerical Recipes in C, (2nd Ed. Cambridge University Press).
6. Thisted, R.A. (1988). Elements of Statistical Computing, (Chapman and Hall).
7. Ross, S. (2005). Introduction to Probability Models, (6th Ed. Academic Press).

AS-406 Practicals- IV (On PC Using Software)

A.   **Practicals based on AS-401 (Introduction to Mathematical Statistics)**   (12 Hrs)
   1. Overview of practicals based on discrete distributions and continuous distributions.
   2. To find various order statistics of a r. s. for given PMF/PDF.
   3. Plotting likelihood functions for the given probability distributions.
   4. Estimation by using methods of moment.
   5. Plotting power function for the given test and concluding the decision based on the observed data using MP/ UMP tests.

B.   **Practicals based on AS-402 (Sampling Theory of Surveys)**   (12 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. H-T estimator and PPS, π PS designs
   6. Stratified Random Sampling: Various kinds of allocation and estimation of population total and mean with S.E.
   7. Ratio method of estimation, Regression method of estimation.
   8. Systematic sampling.

C.   Practicals based on AS-403 (Financial Mathematics-II)   (12 Hrs)
1. Yield rates.
2. Practical application.
3. Advanced practical analysis.
4. Term structure of interest rates.
5. Immunization.

D.   Practicals based on AS-404 (Life Contingencies-I)   (12 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.

E.   Practicals based on AS-405 (Programming in C++ and Numerical Methods)
     (12 Hrs)
1. Writing programs to calculate different summary statistics (mean median, mode, variance, standard deviation, order statistics, range and quantiles) based on the given *n* observations.
2. Programs to compute the c.d.f.'s of standard probability distributions. (Binomial, Poisson, Geometric, Hyper Geometric, Negative Binomial)
3. Drawing random samples from standard distributions (Binomial, Poisson, Geometric, Exponential, Normal, Gamma, Beta, Discrete, Mixture)
4. Drawing a random sample of size *n* using SRSWR and SRSWOR.
5. Programs based on the numerical methods.
    *   Bisection method, Newton-Raphson Method
    *   Numerical Integration by Simpson's rules