Tribhuvan University

Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

CURRICULUM STRUCTURE

Bachelor in Mathematical Sciences (B.Math.Sc.) With Major Actuarial Science - Program

1. Introduction

Actuarial Science deals with evaluating risks and maintaining the economic stability of insurance or financial organisations. Actuarial Studies graduates learn how to use Mathematics, Statistics, and Probability principles to anticipate future events and take preventive measures. Actuaries help individuals; businesses and society manage risk by evaluating the likelihood of future events and creating plans to reduce the negative financial impact of undesirable events. By considering the importance and value of Actuarial science, the School of Mathematical Sciences, Institute of Science and Technology Tribhuvan University has run a Bachelor in Mathematical Sciences (B.Math.Sc.) curriculum with major Actuarial Science since 2016.

The curriculum structure of B.Math.Sc. program is designed to provide the breadth and depth of knowledge needed for a successful career in actuarial science. Students learn about the discipline that assesses finance and applies the statistics and mathematics of probability to define, analyze, and solve the financial implications of uncertain future events. B.Math.Sc. program is a multi-disciplinary subject that includes the use of *Mathematics, Statistics, Computer Science and Information Technology* and other social science subjects to equip students with the tools to help them excel in various actuary fields, such as insurance, finance, investment and risk management.

2. Objectives

This is an interdisciplinary program. By the end of this programme, students should be able to:

- understand and apply various analytic and quantitative methods to define and solve problems in insurance, finance, economics, investment, pension and financial risk management;
- understand and identify the nature of insurance, finance and investment risks;
- develop analytical skills to evaluate and measure various kinds of risk, and appraise the related moral and ethical issues;
- formulate effective business strategies and apply practical knowledge on issues related to actuarial science; and
- prepare to proceed postgraduate level study in a wide range of actuarial science, and business.

3. Duration and Nature of Course

B.Math.Sc. is a full time program of 8 semesters in 4 years in duration. This program basically comprises of some foundational courses consisting of fundamentals of Mathematics, Statistics, Computer Science and Technology including some Social Science and Management course related to Actuarial science.

Total Credit hours: 123 Cr. Hrs.

Nature of Courses: Theoretical, Practical, Project, Seminar and Intern.

4. Eligibility

The candidate applying for admission to the B.Math.Sc. program must have completed 12 or equivalent examinations from any stream (Science / Management / Education / Arts) with minimum second division (securing 45% and above) or Minimum 'C' grade in all subjects of grade 12 by taking at least one Mathematics or Business Mathematics of 100 marks or 5 Credit hrs.

5. Evaluation System

All evaluation schemes will be as per the rule of TU semester system rules and regulations.

a) Internal evaluation: In each subject there will be internal evaluation of 40% of total credits (or 40% marks). Internal exams will be based on: Term Assessments, Attendance, Assignment, Presentation / Viva/ Class seminar / Project work etc.

b) Semester end exam: In each subject there will be final exam at the end of each semester of 60% of total credits (or 60% marks). End semester exam will be conducted by Institute of Science and Technology or School in permission of exam board of TU.

c) Evaluation of project: Research / project will be monitored by supervisor; pre viva by the school after submission; and then evaluation of project by one internal and one external examiner.

d) In each of the semester exam and internal assessment, the student must secure at least 50% marks in each subject in order to complete the course.

6. Teaching Pedagogy

The general teaching pedagogy of B.Math.Sc. includes class lectures, group discussions, case studies, guest lectures, research work, project work (individual and group), assignments (theoretical and practical), and term papers. The teaching faculty will determine the choice of teaching pedagogy as per the need of the course. The concerned faculty shall develop a detailed course outline and work plan at the beginning of each semester.

7. Course Structure

Semester	Papers	Credit
First	BMS 101 Calculus with Analytic Geometry I	3
	BMS 102 Actuarial Statistics I	3
	BMS 103 Programming with C	3
	BMS 104 Communication Practice	3
	BMS 105 Linear Algebra with Applications	3
Total		15

Semester	Papers	Credit
Second	BMS 151 Calculus with Analytic Geometry II	3
	BMS 152 Actuarial Statistics II	3
	BMS 153 R Programming	3
	BMS 154 Technical Writing	2
	BMS 155 Business Finance I	3
	BMS 156 Actuarial Seminar I	1
Total		15

Semester	Papers	Credit
Third	BMS 201 Multivariable Calculus	3
	BMS 202 Microeconomics	3
	BMS 203 Programming with Python	3
	BMS 204 Business Finance II	3
	BMS 205 General Logic	3
Total		15

Semester	Papers	Credit
Fourth	BMS 251 Differential Equations and their Applications	3
	BMS 252 Actuarial Mathematics I	3
	BMS 253 Data Structure and Algorithm	3
	BMS 254 Macroeconomics	3
	BMS 255 Risk Management	3
	BMS 256 Actuarial Seminar II	1
Total		16

Semester	Papers	Credit
Fifth	BMS 301 Discrete Mathematics	3
	BMS 302 Actuarial Mathematics II	3
	BMS 303 Excel for Actuarial Mathematics	3
	BMS 304 Research Methodology	3
	BMS 305 Financial Engineering and Loss Reserving I	3
Total		15

Semester	Papers	Credit
Sixth	BMS 351 Financial Engineering and Loss Reserving II	3
	BMS 352 Investment Strategies and Portfolio Management	3
	BMS 353 Excel for Financial Engineering and Loss Reserving	3
	BMS 354 Compliance Law	3
	BMS 355 Actuarial Project Work	4
Total		16

Semester	Papers	Credit
Seventh	BMS 401 Risk Modelling and Survival Analysis I	3
	BMS 402 Business Management	3
	BMS 403 Modelling Practice	3
	BMS 404 Products and Business Environment of Insurance	3
	BMS 405 Personal and Professional Development (Internship)	4
	Total	16

Semester	Papers	Credit
Eight	BMS 451 Risk Modelling and Survival Analysis II	3
	BMS 452 Actuarial Practice	3
	BMS 453 Pensions and other Benefits	3
	BMS 454 Underwriting and Reinsurance	3
	BMS 455 Sociology and Anthropology	3
	Total	15

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Tribhuvan University

Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

Syllabus

Bachelor in Mathematical Sciences (B.Math.Sc.)

with Major Actuarial Science - **FIRST SEMESTER**

Course Structure (New Course)

Semester	Papers	Credit
First	BMS 101 Calculus with Analytic Geometry I	3
	BMS 102 Actuarial Statistics I	3
	BMS 103 Programming with C	3
	BMS 104 Communication Practice	3
	BMS 105 Linear Algebra with Applications	3
Total		15

Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75

Paper: **Calculus with Analytic Geometry I** *Code No.*: **BMS 101**

Nature: Theory *Credit*: 3

Course Description:

This course includes limits, continuity, differentiation and integration of algebraic and transcendental functions, and their applications.

Learning Objectives:

After successful completion of this course the student will be able to

1. acquire elementary knowledge of calculus and analytical geometry.
2. solve limit, continuity, differentiation and integration problems.
3. apply the techniques of calculus to solve real life problems.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Contents:

Unit 1 Limits and Continuity of Functions 8 hrs

Limit of a function at a point, Computing limits of algebraic functions by definition, Limits at infinity, Continuity at a point, Asymptotes: horizontal, vertical and oblique.

Unit 2 Derivatives 10 hrs

Derivatives and their rules, Linear approximations and differentials, Indeterminate forms and L'Hospital's rule, Higher order derivatives.

Unit 3 Application of Derivatives 10 hrs

Monotonic functions, Optimization problems, Marginal analysis, Roll's theorem and Mean value theorem, Sketching curve using calculus, Newton's method.

Unit 4 Integrals 10 hrs

Definite integral, Fundamental theorems of calculus, Indefinite integrals and their properties, Properties of definite integrals, Numerical methods of integration.

Unit 5 Application of Integration 10 hrs

Areas between curves, Volumes, Volumes by cylindrical shells, Average value of a function, Arc length, Area of a surface of revolution, Applications in economics.

Textbook:

1. Stewart J., *Calculus: Early Transcendental Functions*, 7th edition, Thomson Brooks/Cole.

Reference Books:

1. Larson, et al, *Calculus: Early Transcendental Functions*, Houghton Mifflin, 2011.

2. Robert A. Adams, *Christopher Essex, Calculus: A Complete Course*, Pearson, 2010.

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75

Paper: **Actuarial Statistics I** *Code No*.: **BMS 102**

Nature: Theory *Credit*: 3

Course Description:

This course focuses on fundamental statistical techniques that are of particular relevance to actuarial work. The course covers exploratory data analysis, moments, skewness and kurtosis, correlation and regression analysis, probability, random variable and mathematical expectation, some discrete and continuous probability distributions.

Learning Objectives:

After successful completion of the course the student will be able to

1. understand and use the descriptive statistical tools used in actuarial work.
2. provide summaries of data using appropriate descriptive statistical analysis and graphical presentation.
3. describe the essential features of statistical distributions.
4. calculate and interpret the meaning of correlation coefficient to measure the strength of relationship between two numerical variables.
5. calculate and interpret the meaning of coefficient of determination to measure the predictive power of the simple as well as multiple regression.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Contents:

Unit 1 Data Summarization **10 hrs**

Summarization of set of data using a table or frequency distribution, Histogram, Frequency curve and polygon, Cumulative frequency curve, Stem-and-leaf display, Measures of central tendency, Measures of dispersion, Raw and central moments, Relation between raw and central moments, Properties of moments, Skewness and it's types, Methods of measuring skewness, Five number summary, Box-plot, Kurtosis, Types and methods of measuring kurtosis, Solving numerical problems related to actuarial science.

Unit 2 Correlation and Regression Analysis **8 hrs**

Correlation and its types, Assumptions, Scatter plot and Karl Pearson's correlation coefficient, Spearman's and Kendall's rank correlation coefficient, Response and explanatory variables in regression, Simple and multiple linear regressions, Assumption of linear regressions model, Lines of regressions, Fitting of regression model using ordinary least square method, Interpretation of intercept and slope, residual analysis, Relation between correlation and regression, Measures of variation in regression analysis, Coefficient of determination, Solving numerical problems related to actuarial science.

Unit 3 Probability **4 hrs**

Review of fundamental concepts of probability, Laws of probability, Conditional probability, Pair-wise and mutually independence, Bayes' theorem and its application, Prior and posterior probability, Solving numerical problems related to actuarial science.

Unit 4 Random Variables **6 hrs**

Random variables and their properties, Types of random variables: qualitative (Categorical) and quantitative; discrete and continuous random variables, Probability distribution, Probability mass function, Probability density function and its properties, Functions of

random variable, Linear and non-linear transformation, Joint probability distribution function, Joint probability mass function, Joint probability density function, Conditional probability mass function and conditional probability density function, Solving numerical problems related to actuarial science.

Unit 5 Mathematical Expectation **7 hrs**

Mathematical expectation of a random variable, Properties of mathematical expectation, Addition and multiplicative theorems of expectation, Covariance and correlation, Conditional expectation, Conditional variance, Variance of linear combination of random variables, Moments of random variables, Raw and central moments, Generating functions: moment generating function, Characteristic function, Probability generating function, Cumulant generating function with their properties, Solving numerical problems related to actuarial science.

Unit 6 Discrete Probability Distribution **6 hrs**

Binomial distribution, Poisson distribution, Negative binomial distribution, Geometric distribution, Hyper-geometric distribution; their mass functions, Distribution functions, Mean, Variance, Moment generating functions, Characteristic functions and properties, Solving numerical problems related to actuarial science.

Unit 7 Continuous Probability Distribution **7 hrs**

Normal distribution, Standard normal distribution, Lognormal distribution, Exponential distribution, Gamma distribution, Beta distribution, Uniform distribution; their density functions, Distribution functions, Mean, Variance, Moment generating functions, Characteristic Functions, Properties and uses, Normal distribution as an approximation of Binomial and Poisson distribution, Solving numerical problems related to actuarial science.

Reference Books:

1. John E. *Freund's Mathematical Statistics with Applications*, 8th ed. Miller, I. and Miller, M.; [Freund, J. E.] Prentice Hall International, 2013
2. Knuth, D.E. Stanford CA, *Literate Programming*, Centre for the Study of Language and Information, 1992.
3. Frees, E.W., *Regression Modelling with Actuarial and Financial Implications*, Cambridge University Press, 2010.
4. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying YE, *Probability and Statistics for Engineers and Scientists*, Pearson, 2012.

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **Programming with C** *Code No.*: **BMS 103**
Nature: Theory+Practical *Credit*: 3

Course Description:

This course introduces the both theoretical and practical concepts of C programming language including basic concepts, data types, operators, handling input and output, control statements, arrays, functions, pointers, structures, unions, and file handling.

Course Objective:

The main objective of this course is to familiarize students both theoretical and practical concepts of C programming language.

Mode of Delivery:

The course will be taught by implementing interactive teaching methods using computer technologies in the class room. There will be a project and students will prepare a model as per the instructor/lecturer.

Contents:

Unit 1 Introduction **3 hrs**

Program and programming language, Types of programming languages, Program design tools (Algorithm, Flowchart, and Pseudocode), History of C programming, Structure of C program, Compiling and executing C programs, Debugging.

Unit 2 Basic Elements of C **4 hrs**

C standards, C character set, C tokens, Escape sequence, Delimiters, Variables, Data types, Constants/Literals, Symbolic constant, Expressions, Statements, Writing comments, Library functions and Pre-processor directives.

Unit 3 Data Input and Output **3 hrs**

Input/output operations, Conversion specifications, Formatted I/O and unformatted I/O.

Unit 4 Operators and Expression **5 hrs**

Unary and binary operators, Arithmetic operator, Relational operator, Boolean operator, Assignment operator, Ternary operator, Bitwise operator, Increment or decrement operator, Conditional operator, Special operators(size of operator), Evaluation of expression, Operator precedence and associativity, Type conversion.

Unit 5 Control Statements **6 hrs**

Branching statements (if and switch), Looping statements (for, while, and do-while), Nested control structures, Break and continue statements, Exit function.

Unit 6 Arrays and Strings **6 hrs**

Introduction to array, Types of array (Single dimensional and multidimensional), Declaration and memory representation of array, Initialization of array, Character array and strings, Reading and writing strings, Null character, String library functions.

Unit 7 Functions **6 hrs**

User defined functions, Library functions vs. User defined functions, Function prototype, Function call and Function definition, Nested and recursive function, Function arguments and return types, Passing arrays to function, Passing strings to function, Passing arguments by value, Passing arguments by address, Local and global variable, Scope visibility and lifetime of a variable, Macros.

Unit 8 Pointers **6 hrs**

Introduction to pointers, Advantages and disadvantages of pointer, The & and * operator, Declaration of pointer, Pointer to pointers (Chain of Pointers), Pointer arithmetic, Pointers and arrays, Pointers and character strings, Array of pointers, Pointers as function arguments, Function returning pointers, Dynamic memory allocation.

Unit 9 Structure and Union **5 hrs**

Introduction, Declaration, Initialization, Array of structure, Passing structure to function, Passing array of structure to function, Nested structure, Pointers and structures, Introduction to union, Structure vs union.

Unit 10 File Handling in C **4 hrs**

Concept of file, Types of file (Text and binary files), Modes of file, Opening and closing of file, Input output operations in file, Random access in file.

Laboratory Works:

Laboratory work includes writing C programs to implement all the concepts of C programming studied in each unit of the course.

Text Books:

1. Byron Gottfried, *Programming with C*, Fourth Edition, McGraw Hill Education.
2. Brian W. Keringhan, Dennis M. Ritchie, *The C programming Language*, Second edition, PHI Publication.

Reference Books:

1. Al Kelley, Ira Pohl: *A Book on C*, Fourth edition, Pearson Education.
2. Yeshvant Kanetkar, *Let Us C* , 17 th edition, BPB publication, 2020.
3. Herbert Schildt, C Complete Reference, Fourth edition, Osborne/McGraw- Hill Publication.
4. King K.N., *C Programming*: *A Modern Approach*, Second edition
5. Balagurusamy E., *Programming in ANSI C*, Eigth edition, TMH publication, 2019

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **Communication Practice** *Code No*.: **BMS 104**
Nature: Theory *Credit*: 3

Course Description:

This course aims to help students develop their professional communication skills. As a pre-professional, learning some essential ways to develop appropriate, timely, and persuasive documentation prepares students for the fast-paced demands of an employer, colleagues, and clients. This course seeks to expose students to the professional and technical situations they may encounter in a workplace setting. The course prepares students to perform audience analysis, usability testing, persuasive communication, tailored documentation, and most importantly to involve in professional communication with clarity, concision, style and appropriate tone. Moreover, the course also aims to familiarize students with the native speakers' pronunciation through the use of audio-visual aids.

Course Objectives:

After the successful completion of this course, students will be able to

1. identify appropriate forms of written communication.
2. analyze audience for an intended message.
3. prepare persuasive technical documents.
4. design and revise technical documents for clarity, concision, style, and tone.
5. produce native speaker's pronunciation or speak the way they do.

Mode of Delivery:

The course will be taught by lecture and group discussion. Audio visual aids and Power point presentations are encouraged for effective teaching learning.

Contents:

Unit 1 Foundations of Professional Communication 10 hrs

Introduction to communication, Communication process, Analyzing audience, Communication channels, Crafting your message with plain language, Non-verbal and cross-cultural communication, From shotgun to boomerang: using feedback.

Unit 2 Understanding the Technical Communication Environment 10 hrs

Introduction to technical communication, Objectives in technical communication, Nature and scope of technical communication, Understanding ethical and legal considerations.

Unit 3 Writing Business Messages and Documents 10 hrs

Writing notice and minutes, Writing business letters, The job search: writing letter of application and creating resume.

Unit 4 Persuasive Communication 10 hrs

Communicating persuasively, Emphasizing important information, Creating graphics, designing print and online documents, A picture is worth thousand words: using visuals, Writing advertisements, Writing leaflets

Unit 5 Developing Oral Communication Skills **8 hrs**

Effective listening, Meetings and conferences, Making presentations, Group discussion, Interviews.

Practice

S.N.	Topics	Activity
1.	Listening	1. General instruction on effective listening, factors influencing listening, and note-taking to ensure attention.
		2. Listening to recorded authentic instruction and description followed by exercises.
		3. Listening to recorded authentic conversation followed by exercises.
2.	Speaking	1. General instruction on effective speaking ensuring audience's attention, comprehension and efficient use of Audio-visual aids.
		2. Making students express their individual views on the assigned topics or topics of their choice and making them deliver talk individually and in group.
		3. Getting students to participate in group discussion on the assigned topics.

Equipment Required: Laptop, multimedia, projector and speaker.

Textbooks

1. Burt, Salley, and Gabi, Nudelman. *Professional Communication*, 4th ed., edited by Jane English, Oxford University Press, 2018
2. Gerson, Sharon J., and Steven M. Gerson. *Technical Communication Process and Product*.8th ed., Prentice Hall Press, 2012.

Reference Books

1. Bailey, Edward P. JR, *The Plain English Approach to Business Writing*, Oxford University Press, 1997.
2. Markel, Mike, and Stuart A. Selber, *Technical Communication*, 12thed., Bedford/St. Martin's Publisher, 2017.
3. Markel, Mike ,*Practical Strategies for Technical Communication*. Bedford/St. Martin's Publisher, 2016.
4. Raman, Meenakshi and Sangeeta Sharma, *Technical Communication Principles and Practices*, Oxford University Press, 2015.

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **Linear Algebra with Applications** *Code No.*: **BMS 105**
Nature: Theory *Credit*: 3

Course Description:

This course emphasizing topics useful in other disciplines covers fundamental algebraic tools involving matrices and vectors to study linear systems of equations and linear transformations, eigenvalues and eigenvectors and their wide range of applications.

Learning Objectives:

After successful completion of this course the student will be able to

1. use matrix and determinants to solve various mathematical and real life problems.
2. acquire knowledge of vectors spaces.
3. apply eigenvalues and eignvectorsin solving various problems.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Contents:

Unit 1 Matrix and Determinants **10 hrs**

Algebra of matrices, Determinants and its properties, Application of determinants, Complex matrices, Rank of matrices, System of linear equations and its matrix form, Row reduction and echelon forms, Applications of linear system and LU factorization.

Unit 2 Vectors Spaces **12 hrs**

Points in n-space, Algebra of points in n-space, Scalar and dot product, Norm and its properties, Distance, Angle between two vectors, Orthogonality, Scalar and vector projections, Cosines of lines, Projections, Vector spaces and subspaces, Linear combination, dependence and independence, Span, basis and dimension.

Unit 3 Linear Transformations **8 hrs**

Linear transformations, Kernel and image, Algebra of linear transformations, Matrix representation of a linear transformations, Four fundamental subspaces, Applications to difference equations, Applications to Markov chains.

Unit 4 Orthogonality **8 hrs**

Orthogonal vectors and sets, Orthogonal bases and Gram-Schmidt, QR-factorization, Least squares method.

Unit 5 Eigenvalues and Eigenvectors **10 hrs**

Eigenvalues and Eigenvectors, Cayley- Hamilton theorem and its application, Eigenvalue decomposition, Diagonalization of a matrix, Difference equations and powers A^k, Singular value decomposition.

Textbook:

1. David C. Lay, *Linear Algebra and its Applications*, Pearson Education, 2012,

Reference Books

1. Gilbert Strang, *Introduction to Linear Algebra*, 4th Edition, Wellesley- Cambridge Press.
2. Howard Anton, Chris Rorres, *Elementary Linear Algebra*: *Applications Version*, Wiley, 2014.

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Tribhuvan University

Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

Syllabus

Bachelor in Mathematical Sciences (B.Math.Sc.)

with Major Actuarial Science - **SECOND SEMESTER**

Course Structure (New Course)

Semester	Papers	Credit
Second	**BMS 151 Calculus** with Analytic Geometry **II**	**3**
	BMS 152 Actuarial Statistics II	**3**
	BMS 153 R Programming	**3**
	BMS 154 Technical Writing	**2**
	BMS 155 Business Finance I	**3**
	BMS 156 Actuarial Seminar I	**1**
Total		**15**

Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **Calculus with Analytic Geometry II** *Code No.*: **BMS 151**
Nature: Theory *Credit*: 3

Course Description:

This course is a continuation in Calculus and Analytic Geometry I. It covers Beta and Gamma functions, parametric equations and polar coordinates. It also focuses on the comprehensive treatment of infinite sequence and series, partial derivatives, optimization problems and multiple integrals.

Learning Objectives:

After successful completion of this course the student will be able to

1. work with improper integrals.
2. solve problems of infinite sequences and series.
3. use techniques of multivariable calculus.
4. apply the techniques of calculus to solve real life problems.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Contents:

Unit 1 Beta and Gamma Functions 7 hrs

Improper integrals, Beta and Gamma functions and their properties, Reduction formulae, Differentiation under the integral sign.

Unit 2 Parametric Equations and Polar Coordinates 8 hrs

Curves defined by parametric equations, Calculus with parametric curves, Polar coordinates, Areas and lengths in polar coordinates, Conic sections, Conic sections in polar coordinates.

Unit 3 Infinite Sequences and Series 12 hrs

Sequences, Series, Comparison tests, Alternating series, Absolute convergence, Ratio test, Root test, Integral test and estimates of sums, Power series, Taylor and Maclaurin series, Taylor polynomials and their applications.

Unit 4 Partial Derivatives 12 hrs

Functions of two and three variables, Limits and continuity, Partial derivatives, Higher order partial derivatives, Tangent planes and linear approximations, Directional derivatives and gradient vector, Total differentials, Euler's theorem of two and three variables, Maximum and minimum values, Lagrange multipliers.

Unit 5 Multiple Integrals 9 hrs

Double integrals over rectangle, Iterated integrals, Double integrals over general regions, Double integrals in polar coordinates, Applications of double integrals, Triple integrals, Change of variables in multiple integral.

Textbook:

1. Stewart J., *Calculus: Early Transcendental Functions*, 7th edition, Thomson Brooks/Cole.

Reference Books:

1. Larson, et al, *Calculus: Early Transcendental Functions*, Houghton Mifflin, 2011.
2. Robert A. Adams, Christopher Essex, *Calculus: a complete course*, Pearson, 2010.

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **Actuarial Statistics II** *Code No.*: **BMS 152**
Nature: Theory *Credit*: 3

Course Description:

This course focuses on fundamental statistical techniques that are of particular relevance to actuarial work. The course covers sampling distribution, estimation, central limit theorem, hypothesis testing, generalized linear models and Bayesian statistics.

Learning Objectives:

After successful completion of the course the student will be able to

1. calculate the sampling distribution of the sample mean, proportion and sample variance.
2. describe and apply the principles of statistical inference.
3. describe, apply and interpret the results of generalized linear models.
4. explain the fundamental concepts of Bayesian statistics and use them to compute Bayesian estimators.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Contents:

Unit 1 Sampling Distributions and Central Limit Theorem 10 hrs

Random sample, Parameter and statistics, Sampling distribution of the sample mean, Proportion and sample variance (SRS with /without replacement), Standard errors of sample mean and sample proportion. Chi-square (χ^2), t and F distributions and their properties and application, Inter-relation between the distributions, Central limit theorem, Lindeberg-Levy central limit theorem and their applications.

Unit 2 Estimations 10 hrs

Point estimation: Estimation of parameter, Characteristic and properties of a good estimator: unbiasedness, Consistency, Efficiency and mean square error. Likelihood function and properties. Method of maximum likelihood estimation (Binomial, Poisson and Normal) and method of moments and their properties, Cramer –Rao inequality.

Interval Estimation: Confidence intervals of mean and difference of means, Confidence intervals for proportion and difference of proportions. Confidence interval for a difference between two means for paired data, Confidence interval estimate of correlation and regression coefficients, Confidence interval for variance, Need of reporting confidence interval, Interpretation of confidence interval.

Unit 3 Hypothesis Testing 10 hrs

Parametric and non-parametric hypothesis, Null and alternative hypothesis, Simple and composite hypothesis, Type first and type second errors, Critical region, Level of significance, Power of the test, p-value in testing of hypothesis, Likelihood ratio test, Statistical test: One sample test for mean of normal population (known and unknown variance), Test for proportion, Test for difference between two means and two proportions, Paired sample t-test, Significance test of correlation and regression coefficients, F- test: Two independent sample tests for variances of normal populations, Assumptions of these statistical tests, Non parametric test: Chi square test; Independence of attributes and goodness

of fit, Permutation approach to non-parametric hypothesis tests, Solving numerical problems related to actuarial science.

Unit 4 Generalized Linear Models **10 hrs**

Concept of generalized linear models, Exponential family of distribution, Conversion of Binomial, Poisson, Exponential, Gamma and Normal distributions into exponential family, Mean and variance for an exponential family, Variance function and scale parameters, Link and canonical link function, Variable and factor taking categorical values, Linear predictor, Deviance and scaled deviance, Parameters of GLM and its estimation, Pearson and deviance residuals, Determination of the acceptability of a fitted model (Pearson's Chi-square test and the likelihood ratio test), Fitting of generalized linear model to data set and interpretation of output, Application of generalized linear models in actuarial science.

Unit 5 Bayesian Statistics **8 hrs**

Bayes' theorem, Prior, Posterior and conjugate prior distributions, Derivation of the posterior distribution for a parameter in simple cases, Loss function, Expected loss function, use of loss function to derive Bayesian estimates of parameter, Properties of Bayes' estimator, Credibility premium formula, Bayesian approach to credibility theory and its use to derive credibility premiums in simple cases .

Reference Books:

1. Denuit, M., Hainaut, D. and Trufin, J., *Effective Statistical Learning Methods for Actuaries*: I. [Generalised Linear Models] GLMs and extensions. - Springer, 2019
2. McCullagh, P. and Nelder, J.A., *Generalized Linear Models*. 2nd ed., Chapman & Hall/CRC Press, 1989
3. Freund, J. E., *Freund's Mathematical Statistics with Applications,* 8th ed. Miller, I. and Miller, M.; [] Prentice Hall International, 2013
4. Knuth, D.E. Stanford CA, *Literate Programming*, Centre for the Study of Language and Information, 1992.
5. Frees, E.W., *Regression Modeling with Actuarial and Financial Implications*, Cambridge University Press, 2010.
6. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying YE, *Probability and Statistics for Engineers and Scientists*, Pearson, 2012.

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Program: Bachelor in Mathematical Sciences(B.Math.Sc.) *Full Marks*: 75
Paper: **R Programming** *Code No*.: **BMS 153**
Nature: Theory and Practical (1+2) *Credit*: 3

Course Description:

The course focuses on computational aspects (that is, syntax and general programming tools) of statistical modeling and analysis, covered by BMS102 Actuarial Statistics I and BMS152 Actuarial Statistics II. It covers the fundamental syntax and object types used across all aspects of R programming, and develops probability distributions, data analysis statistical inference, regression theory in statistical software environment R programming.

Learning Objectives:

On successful completion of this course, a student will be able to

1. acquire a solid exposure to the statistical software environment R.
2. interact with data using R and R Studio.
3. utilize simulation to explore statistical properties of models.
4. conduct hypothesis testing in R.
5. apply R programming in data analysis and actuarial field.

Mode of Delivery:

The course will be taught by implementing interactive teaching methods using computer technologies in the class room. There will be a project and students will prepare a model as per the instructor/lecturer.

Contents:

Unit 1 Introduction to the R Language **6 hrs**

Basic Data Types, Visualizing data using R**, R** graphics system, Plotting in R Studio, ggplot2.

Unit 2 Data Summarization **6 hrs**

Frequency distribution, Measures of central tendency, Measures of dispersion moments, Skewness, Kurtosis, Box-plot, Probability.

Unit 3 Correlation and Regression Analysis **7 hrs**

Correlation, Analysis of variance, Simple linear regression, Multiple linear regression: Maximum likelihood estimation for regression, Standard errors, *t*-Values, and *p*-Values.

Unit 4 Discrete and Continuous Probability Distributions **10 hrs**

Families of discrete and continuous distributions, The d, p, q, and r functions

Unit 5 Random Variables and Mathematical Expectation **6 hrs**

Expectations, Central limit theorem. Random sampling, Sampling distributions.

Unit 6 Statistical Inference **7 hrs**

Simulation, Significance tests, Estimation, Standard errors, Confidence intervals and prediction intervals, Hypothesis testing, Goodness of fit, Maximum likelihood estimation, Bayesian analysis.

Unit 7 Generalized Linear Models **6 hrs**

Generalized linear models and the glm () function, Elements of GLM, fitting of generalized linear model to data set and interpretation of output, Gaussian distribution, Logistic regression, Poisson regression.

References:

1. David Dalpiaz, *Applied Statistics with R*, https://daviddalpiaz.github.io/appliedstats/applied_statistics.pdf
2. Tilman M. Davies, *The book of R*: a first course in programming and statistics, No Starch Press.2016
3. John Verzani, *Using R for Introductory Statistics*, CRC Press New York
4. Venables W. N., Smith D. M. and the R Core Team, *An Introduction to R*, https://cran.r-project.org/doc/manuals/R-intro.pdf
5. Julian J. Faraway, *Practical Regression and Anova using R*, https://cran.r-project.org/doc/contrib/Faraway-PRA.pdf
6. Peng R. Victoria, Report writing for data science in R. Lean Publishing, 2015.

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Program: Bachelor in Mathematical Sciences (B.Math.Sc.) *Full Marks*: 50
Paper: **Technical Writing** *Code No*.: **BMS 154**
Nature: Theory *Credit*: 2

Course Description:

Technical Writing is an introduction to technical and professional writing. This course describes the entire development, process-planning, writing, visual design, editing, indexing, and production of technical documentation. The course presents students with practical information about communicating in different workplace environments and professional/technical discourse communities. The course aims to help students produce and analyze common technical writing genres, including emails, letters, resumes, memos, reports, proposals, technical descriptions, technical definitions, and technical manuals. Moreover, the course also aims to familiarize students with the native speakers' pronunciation through the use of audio-visual aids.

Learning Objectives:

After the successful completion of the course, students will able to

1. analyze and react to rhetorical situations including issues of audience, organization, visual design, style, and the material production of technical documents.
2. produce professional caliber technical documents.
3. produce technical documents both collaboratively and independently.
4. refine writing style for clarity, concision, coherence, cohesion, and emphasis.

Mode of Delivery:

The course will be taught by lecture and group discussion. Audio visual aids and Power point presentations are encouraged for effective teaching learning.

Contents:

Unit 1 Plain English **5 hrs**

Plain English, Style: writing a readable sentence, Organization: getting to the point, Layout: adding visual impact, A model for writing.

Unit 2 Defining Technical Writing **5 hrs**

Rules of good writing, Objectivity in technical writing, Technical writing process.

Unit 3 Business Correspondence **5 hrs**

Memos: Proposes and criteria, Fax messages: Dealing with Fax messages, Electronic mails: Importance and challenges, Writing samples.

Unit 4 Visual Appeal **5 hrs**

Document design**,** Graphics.

Unit 5 Technical Applications **6 hrs**

Fliers, Brochures and newsletters, Writing technical descriptions, Instructions and user manuals.

Unit 6: Report Strategies **6 hrs**

The summary, Research, Reports: Formal and informal reports, Proposals, Oral communication.

Practice

S.N.	Topics	Activity
1.	Listening	Listening to recorded authentic instruction and description followed by exercises.
2.	Speaking	Making students express their individual views on the assigned topics or topics of their choice and making them deliver talk individually and in group.

Equipment Required: Laptop, multimedia, projector and speaker.

Textbooks

1. Gerson, Sharon J., and Steven M. Gerson. *Technical Writing Process and Product*. 5th ed., Prentice Hall Press, 2012.
2. Raman, Meenakshi, and Sangeeta Sharma. *Technical Communication Principles and Practices*. Oxford University Press, 2015.

Reference Books

1. Bailey, Edward P. JR. *The Plain English Approach to Business Writing*. Oxford University Press, 1997.
2. Burt, Salley, and Gabi, Nudelman. *Professional Communication*, 4th ed., edited by Jane English, Oxford University Press, 2018
3. Markel, Mike, *Practical Strategies for Technical Communication*. Bedford/St. Martin's Publisher, 2016.

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Tribhuvan University
Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences | *Full Marks*: 75
Paper: **Multivariable Calculus** | *Code No.*: **BMS 201**
Nature: Theory | *Credit*: 3

Course Description:

This course is the extension of calculus in one variable to calculus with functions of several variables. The topics are related to vectors geometry and function in space, vector calculus, Fourier analysis, complex differentiation and complex integration.

Learning Objectives:

After successful completion of this course the student will be able to

1. Acquire the knowledge of vectors geometry and vector calculus.
2. Obtain the elementary knowledge of Fourier series and Fourier transform.
3. Achieve the basic concepts of complex differentiation and complex integration.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Vector Geometry and Vector Functions **8 hrs**

Three dimensional coordinate systems, Vector equations of lines and planes, Cylinders and quadric surfaces, Vector functions, Derivative and integral of vector functions, Arc length and curvature.

Unit 2 Vector Calculus **10 hrs**

Vector Fields, Line integrals, Fundamental theorem for line integrals, Green' s theorem, Curl and divergence, Parametric surfaces and their areas, Surface integrals, Stoke' s theorem, Divergence theorem.

Unit 3 Fourier Analysis **10 hrs**

Fourier series, Periodic functions, Odd and even functions, Fourier series for arbitrary range, Half range Fourier series, Fourier integral theorem, Fourier sine and cosine integral; Complex form of Fourier integral, Fourier transform, Fourier sine transform, Fourier cosine transform and their properties.

Unit 4 Complex Differentiation **8 hrs**

Complex numbers, Polar form of a complex numbers, Functions and sets in the complex plane, Limits, continuity and derivatives of complex functions, Analytic functions, Cauchy – Riemann equations, Laplace's equation, Exponential function, Trigonometric and Hyperbolic functions.

Unit 5 Complex Integration **12 hrs**

Line integrals in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, Complex power series, Functions represented by power series, Taylor and Maclaurin series, Laurent series, Singularities and zeros, Residue integration method, Residue integration of real integrals.

References:

1. Stewart ,J. ,*Calculus – Early Transcendental Functions,* 7th edition, Thomson Brooks/Cole.
2. Kreyszig, E. , Advance Engineering Mathematic, Tenth edition, Wiley, New York.
3. Larson, et al *, Calculus: Early Transcendental Functions*, Houghton Mifflin, 2011.
4. Robert A. Adams *, Calculus* : *A Complete Course*, Christopher Essex. Pearson, 2010.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Microeconomics** — *Code No.*: **BMS 202**
Nature: Theory — *Credit*: 3

Course Description:

The course covers Economic models, Competitive markets, Consumer demand, and behaviour, Production, Cost and revenue functions, and market, pricing strategies.

Learning Objectives:

Upon successful completion of the course, the student will be able to introduce the core economic principles and how these can be used in a business environment to help decision-making and behavior. It provides the fundamental concepts of macroeconomics that explain how economic agents make decisions and how these decisions interact. It explores the principles underlying macroeconomics that explain how the economic system works, where it fails, and how decisions taken by economic agents affect the economic system.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Economic Models and Recent Historical Applications 8 hrs

Relevance of economics to the world of business: opportunity cost and scarcity and their relevance to economic choice, economic concepts involved in choices made by businesses relevant to the selection of outputs, inputs, technology, location, and competition, Contrast microeconomics and macroeconomics, Main strands of economic thinking: Classical, Marxian, socialism, neo-classical, Keynesian, neo-Keynesian and post-Keynesian, Monetarist, and Austrian.

Analyze the Recent Macroeconomic History

Progress of the world economy since the Great Depression: a history of banking crises and irrational behavior, consequences of banking crises, the Banking crisis of 2008, the Great Recession and recovery, Effectiveness of the monetary policy in the 2008 financial crisis, and the government's actions to combat the recession, Aftershocks in Europe following the 2008 financial crisis., Stimulus-austerity debate and regulatory action after the 2008 crisis.

Unit 2 Competitive Markets 10 hrs

The market operation, Price mechanism in a free market, Behaviour of firms and consumers in free markets, Market demand and supply, Market equilibrium quantity and price, Market reaction to changes in demand and supply, Price and income elasticities of demand, Price elasticity of supply, Effect of elasticity on the workings of markets in the short and long run, Risk and uncertainty about future market movements, Price expectations, and speculation, Price bubbles.

Unit 3 Consumer Demand and Behaviour 7 hrs

Concept of utility, Representation of consumer preferences as indifference curves, Rational choice, Optimal consumption choice, Perfect information and irrational behavior in behavioural economics, the importance of advertising for a firm,and effects of advertising on sales and demand.

Unit 4 Production, Cost and Revenue Functions **8 hrs**

Production function, Production costs, Reflection of production function in the relationship between inputs and outputs in the short and long run, Average and marginal physical product, Measurement of costs and their relation with output in the short and long run, Total, average and marginal costs, Economies of scale, Efficiency in selecting the level of inputs, Revenue and profit, Influence of market conditions on revenue and profit, Average and marginal revenue, Measurement of profit, Profit maximizing output of a firm, "shut-down" point in the short and long run.

Unit 5 Market **10 hrs**

Profit maximization under perfect competition and monopoly, Market power of a firm, Main features of a market characterized by perfect competition, output and price in such markets in the short and long run, Monopolies, Barriers to entry in an industry, and a contestable market. Profit maximization under imperfect competition, Behaviour of firms under monopolistic competition, features of an oligopoly, Behaviour of firms in an oligopoly, Determining factors of competition and collusion of firms in an oligopoly, and Explanation of the strategic decisions of such firms by game theory.

Unit 6 Pricing Strategies **5 hrs**

Various pricing strategies of firms, various pricing strategies that firms in the financial services sector can adopt, Determination of prices in practice, Pricing ability of a firm, Average cost pricing, Price discrimination, Pricing strategy for multiple products, Pricing and life of a product.

References:

1. J., Hinde, K., and Garratt, D. Sloman, *Economics for Business*, 5th edition, Prentice Hall,2010.

2. Begg, D. K. H.; Fischer, S.; Dombusch, R., *Economics*, 8th edition , Mc Graw-Hill,2005.

3. Lipsey, R. G.; Chrystal, K. A., *Economics*, 11th edition, Oxford University Press,2007.

4. Mankiw, N.G.; Taylor, M P. Thomson, *Economics*, 2006.

5. Parian, M, Powell, M.; Matthews, K., *Economics*, 7th edition, Pearson Education,2007.

6. Sloman, J., *Essentials of economics*, 4th edition, FT Prentice Hall,2006.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Programming with Python** — *Code No*.: **BMS 203**
Nature: Theory + Practical — *Credit*: 3

Course Description:

This course covers different concepts of Python programming including basic language concepts, control statements, functions, comprehensions, generators, decorators, iterators, object-oriented programming concepts, exception handling, file handling, modules and packages, and some common Python libraries.

Course Objectives:

The main objective of this course to provide knowledge to student with different concepts of Python programming language python programming and some common Python libraries such as Numpy, Pandas, and Matplotlib.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Introduction **3 hrs**

Python introduction; Why Python; Installing Python; Using interactive shell from console; Running Python scripts from console; Using interactive shell from IDLE; Using IDEs; Installing third party libraries; Writing comments; Indentation; Variables; Operators

Unit 2 Built-In Data Types **7 hrs**

Numbers – integers, Booleans, Real numbers, Complex numbers, Fractions and decimals; Immutable sequences – strings, bytes, and tuples; Mutable sequences – lists, bytearrays; Set types; Mapping types – dictionaries; Dates and times; Collections module; Small value cashing; Indexing and slicing.

Unit 3 Conditionals and Iterations **5 hrs**

Introduction; The if statement; The for loop; The while loop; The break and continue statements; The else clause after for or while loops; The walrus operator

Unit 4 Functions **4 hrs**

Introduction; Why use functions? Defining functions; passing arguments; Return values and returning multiple values; Recursive function; Anonymous function; Built-in functions

Unit 5 Comprehensions and Generators **3 hrs**

The map, zip, and filter functions; Comprehensions – list, Dictionary and set comprehensions; Generators

Unit 6 Object-oriented Programming, Decorators, Iterators, and Modules **14 hrs**

Decorators; Object-oriented programming concepts; Creating class and object; Inheritance; Static methods and class methods; Private properties; The property decorator; Operator overloading; Writing custom iterator; Modules and packages.

Unit 7 Exception and File Handling **4 hrs**

Exceptions; Handling exceptions; Defining your own exception; Reading and writing files; Reading and writing CSV files.

Unit 8 Basic Data Processing and Analysis Using Python Libraries 6 hrs

Numpy: Introduction array creating; Dimensions; Data types, Array attributes, Indexing and slicing; Array copy and view; Creating array from numerical range; Array broadcasting; Iterating over array; Sorting and Searching; Statistical Functions

Pandas: Series and data frames; Creating data frames; The head and tail functions; Attributes; Working with missing data; Indexing, slicing, and subsetting; Merging and joining data frames; Working with CSV data.

Unit 9 Data Visualization with Matplotlib 2 hrs

Introduction; Marker; Line; Color; Label; Grid lines; Subplot; Scatter plot; Bra graph; Histogram, pie chart and box plot.

Laboratory Work:

The laboratory work includes writing computer programs using Python programming language covering all the concepts studied in each unit of the course.

References:

1. Fabrizio Romano and Heinrich Kruger, *Learn Python Programming – An in-depth Introduction to the Fundamentals of Python*, 3rd Edition, Packt Publishing, 2021
2. Kenneth A Lampart, *Fundamental of Python*, Cengage Learning Publishing.
3. Cody Jackson , *Learn Programming in Python with Cody Jackson*, Packt Publishing, Wesley, 2018
4. Mark Summerfield, *Programming in Python 3: A Complete Introduction to the Python Language*, Addison-Wesley Professional.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Business Finance II** — *Code No.*: **BMS 204**
Nature: Theory — *Credit*: 3

Course Description:

The course covers to corporate governance and organization, Sources of financing, Introduction of taxation, Capital structure and dividend policy, Financial restructuring, Cost of capital, and capital budgeting.

Course Objectives:

On successful completion of the course, the student will be able to

1. Learn and understanding of concept and the theories of corporate finance.

2. Develop skills to analyze issues in corporate finance for sound financial decision in business.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Corporate Governance and Organization **8 hrs**

Concept , Characteristics and roles of corporate governance and organization, Types of firm/organization, Corporate finance, business ethics and financial reporting , Corporate reporting ,Social disclosure requirement, financial reporting on environmental, social and economic sustainability , Capital market and money market, Goals of firm : sales maximization, wealth maximization, Corporate social responsibility, Corporate governance and managerial accounting, Changing roles of financial management and managerial accounting,

Unit 2 Sources of Financing **5 hrs**

Concept of financing sources, Differences types of short term, medium term and long term of company finance, Alternative method of raising finance outside the regular banking,

Meaning of share capital, Types of share capital: Authorized, issued, subscribed, called up, and paid-up capital, Meaning and types of share: common stock and preference shares, Types of preference shares-cumulative, non-cumulative, participating and non-participating, redeemable and irredeemable.

Unit 3 Corporate Taxation **6 hrs**

Meaning and objectives of tax, Types of tax, Cannons of taxation, Personal taxation of income and capital gains, Different system of company taxation from the points of view of an individual shareholders and the company, Basic principles of double taxation relief, Taxation and capital structure, Concept of value added tax, Features of income tax act 2058,Tax planning, Relationship between taxation and auditing.

Unit 4 Capital Structure and Dividend Policy **8 hrs**

Concept of capital structure, Capital structure and firm value, Leverage and its types ,Dividend policy and firm value, Relationship between growth and profitability, Concept of dividend, types of dividend policies, factors influencing dividend policy, forms of dividends, reasons for issuing the stock dividend, stock dividend and stock split, Repurchase of stock, stock warrant.

Unit 5 Corporate Restructuring **6 hrs**

Concept of merger and acquisition, Motives of merger, Types of merger, Methods of evaluating target company, Friendly takeover, Hostile takeover, Differential efficiency and financial synergy.

Unit 6 Cost of Capital **5 hrs**

Concept, Importance of cost of capital, Factors affecting cost of capital, Classification of cost, Computation of specific cost of capital- cost of equity, Cost of preference shares, Cost of debt, Weighted average cost of capital (WACC).

Unit 7 Capital Budgeting/Investment Analysis **10 hrs**

Concept and meaning of capital budgeting, Needs and importance of capital budgeting, Features of capital budgeting decisions, Types of proposals, Capital budgeting process, Estimation of cash flow: Net investment cost or net cash outlay (NCO), Annual cash flow after tax, Evaluation technique of project: Traditional method and discounted cash flow method.

References:

1. Van Horne James, C., *Financial Management and Policy*, 12/E, Pearson Education India, 2002.
2. Brealey, R. A., Myers, S. C., Allen, F., and Mohanty P., *Principles of Corporate Finance,* Tata McGraw-Hill Education, 2012.
3. Ehrhardt, M. C., and Brigham, E. F., *Financial Management: Theory and Practice,* South-Western Cengage Learning, 2011.
4. CB1- Business Finance/Institute and Faculty of Actuaries (https://www.actuaries.org.uk/)
5. Nepal Financial Reporting Standards, ASB Nepal, 2018.
6. Garrison R.H,Noreen E.W. and Brewer P.C., *Managerial Accounting,* New Delhi: Tata McGraw Hill, 2014.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **General Logic** — *Code No.*: **BMS 205**
Nature: Theory — *Credit*: 3

Course Description:

Logic is concerned with good reasoning; as such, it stands at the core of the science. This course will discuss the forms and functions of language, theories of deductive logic, and inductive methods. The course will emphasize on the skills of understanding complex materials by analyzing their logical structures, and the skills of constructing clear and convincing arguments by following the basic logical principles.

Learning Objectives:

After successful completion of this course the student will be able to

1. Acquire knowledge of the principles of correct reasoning.
2. Gain practice in exploring the questions, methods and approaches of the discipline of logic.
3. Acquire the abilities to recognize, analyze, and criticize arguments in the contexts of reading, writing, thinking, and discussion.
4. Acquire skill in emphasize balanced argument and critical thought.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Basic Concepts **12 hrs**

Arguments, Structure of arguments, Deductive and inductive arguments, Argument forms, Fallacies and their classifications.

Unit 2 Categorical Propositions **10 hrs**

Categorical propositions, Quality, Quantity and distribution, Venn diagrams and the modern square of opposition, Conversion, Obversion, and contraposition of a categorical proposition, Translating ordinary language statements into categorical form, Standard form, mood and figure of a categorical syllogism, Reducing the number of terms, Enthymemes.

Unit 3 Propositional Logic **10 hrs**

Symbols and translation, Truth functions, Truth tables for propositions, Truth tables and indirect truth tables for arguments, Truth trees for argument, Argument forms and fallacies, Rules of inference, Conditional proof, Indirect proof, Proving logical truths.

Unit 4 Predicate Logic **8 hrs**

Symbols and translation, Using the rules of inference, Quantifier negation rule, Conditional and indirect proof, Proving invalidity.

Unit 5 Inductive Logic and Hypothetical Reasoning **8 hrs**

Inductive generalization, Analogical reasoning, Causality and Mill's methods, Hypothetical method, Hypothetical reasoning, Proof of hypotheses.

References:

1. Patrick J. Hurley, *A Concise Introduction to Logic*, 13th edition. Wadsworth Publishing Company, 2018.
2. Irving M. Copi, and Carl Cohen and Kenneth McMahon, *Introduction to logic*. 14th edition, Pearson International edition, 2014.
3. Kelley, David, *The Art of Reasoning*: *An Introduction to Logic and Critical Thinking*. W. W. Norton & Company, NY, 2014.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Differential Equations and their Applications** — *Code No.*: **BMS 251**
Nature: Theory — *Credit*: 3

Course Description:

This course introduces differential equations and their applications. It covers first, second and higher order differential equations. It also includes system of first order linear equations, series solution of second order linear equations, Laplace transform and their applications.

Learning Objectives:

After the successful ending of this course the student will be able to

1. Solve first, second and higher order differential equation.
2. Solve system of first order linear equations.
3. Apply Laplace transform in solving initial value problems.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 First Order Differential Equations **12 hrs**

Differential equations and its classification, Solution of differential equations, Some basic mathematical models and direction fields, Separable equations, Homogeneous differential equations, Exact equations, Linear equations, Bernoulli equations, Modeling with first order equations, Autonomous equations and population dynamics, Numerical approximations: Euler's method, Existence and uniqueness theorem, first order higher degree differential equations.

Unit 2 Second and Higher Order Linear Equations **12 hrs**

Second order linear equations, Homogeneous equations with constant coefficients, Linear homogeneous equation and Wronskian, Real and complex roots of the characteristic equation, Reduction of order, Non-homogeneous equations; Methods of undetermined coefficients and variation of parameters, General theory of nth order linear equations, *n*th order homogeneous equations with constant coefficients, Methods of undetermined coefficients and variation of parameters for *n*th order linear equations.

Unit 3 System of First Order Linear Equations **6 hrs**

Linear algebraic equations; Linear independence, eigenvalues, eigenvectors, Basic theory of first order linear equations, Homogeneous linear system with constant coefficients, Complex eigenvalues.

Unit 4 Series Solution of Second Order Linear Equations **8 hrs**

Series solutions near an ordinary point, Regular and irregular singular points, Euler equations, Series solutions near a regular singular point, Bessel equation.

Unit 5 Laplace Transform **10 hrs**

Laplace transform and its properties, Inverse Laplace transform and its properties, Step functions, Differential equations with discontinuous forcing functions, Impulse functions, Convolution integral, Application of Laplace transform to initial value problems.

References:

1. Boyce, W. and DiPrima, R., *Elementary Differential Equations and Boundary Value Problems*, 9th edition., Wiley India.
2. James C. Robinson, *An Introduction to Ordinary Differential Equations*, Cambridge University Press.
3. Shepley L. Rose , *Differential Equations*, 3rd edition, James Wieley India, 2010.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Actuarial Mathematics I** — *Code No.*: **BMS 252**
Nature: Theory — *Credit*: 3

Course Description:

This course is a grounding in the principles of modeling as applied to actuarial work focusing particularly on deterministic models which can be used to model, and value known cashflows as well as those which are dependent on death, survival, or other uncertain risks.

Learning Objectives:

After the successful completion of this course the student will be able to

1. Describe, interpret, and discuss the theories on interest rates.
2. Describe the basic principles of actuarial modelling.
3. Describe, interpret, and discuss the equation of value and its application.
4. Describe, interpret, and discuss the life table for mortality and morbidity.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Data and Basics of Modeling **6 hrs**

Basics of data analysis, Principles of modeling, Cash flow model to describe financial transactions.

Unit 2 Theory of Interest Rate **14 hrs**

Time value of money, Interest rate : Simple and compound, Rate of interest payable p times per measurement period , Real and money interest rate, Discounting and accumulations of cashflows, Annuities :Level, increasing and decreasing .

Unit 3 Equation of Value and its Applications **14 hrs**

Equation of value, Uses of equation of value: Loan schedules, price or yield of financial instruments, Project appraisal: Net cash flow, Net present value, Accumulated profit, Internal rate of return, Payback period, discounted payback period, and discussion of suitability of an investment project.

Unit 4 Term Structure of Interest Rates **8 hrs**

Term structure of interest rates, Factors influencing term structure of interest rates, Discrete and continuous rates, Asset liability management:Duration, convexity,immunization of cash flows and Redington's conditions of immunizations.

Unit 5 Life Table **6 hrs**

Life table functions and its notations, Probabilities of death and survival, Constructing life table, Life table functions at non integer ages: Uniform distribution of death and constant force of mortality, Calculating probabilities by using life table, Select mortality.

References:

1. Kellison, *The Theory of Interest*, Irwin Mc-Graw Hill, 2006.
2. Bowers, L. Newton, *Actuarial Mathematics*, Society of Actuaries, 2006.
3. Mark S. Joshi, *The Concepts and Practice of Mathematical Finance*, CambridgeUniversity Press, 2008.
4. McCutcheon, J. J.; Scott, W. F. Heinemann, *An Introduction to the Mathematics of Finance*, Institute and Faculty of Actuaries' Online Publications Shop, 1986.
5. Ross, S. M , *An introduction to Mathematical Finance*, Cambridge University Press.
6. Dickson, D.C.M.; Hardy, M.R.; Waters, H.R., *Actuarial Mathematics for Life Contingent Risks*, 3rd edition, Cambridge University Press, 2020.
7. Kellison, S. G. ,*The Theory of Interest*, 3rd ed. McGraw-Hill-Irwin, 2008.
8. Promislow, D. ,*Fundamentals of Actuarial Mathematics*, 3rd edition,John Wiley, 2015.
9. Wilders. R.J., *Financial Mathematics for Actuarial Science*, CRC Press, 2020.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75

Paper: **Data Structure and Algorithms** — *Code No*.: **BMS 253**

Nature: Theory + Practical — *Credit*: 3

Course Description:

The aim of this course is to develop concepts of data structures and algorithms. The course helps the students to discover the concepts of data structures, different ADTs, recursion, tree, searching, sorting, graph and different algorithms.

Course Objectives:

The main objective of this course is to provide students knowledge of different concepts of data structures, ADTs, and algorithms so that they will be able to implement these concepts in different fields.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to develop computer programs related to the concepts using C/Python after completion of each chapter.

Course Contents:

Unit 1 Introduction to Data Structure **3 hrs**

Data types, Concept of data structure, Abstract data type, Implementation of data structure, Introduction to algorithms, Basics of asymptotic notations

Unit 2 The Stack **4 hrs**

Definition, Stack as an ADT, Stack operations, Stack application: Evaluation of infix, postfix, and prefix expressions, Conversion of infix to post/prefix expression

Unit 3 Queue **3 hrs**

Definition, Queue as an ADT, Primitive operations in queue, Linear and circular queue and their application, Array based queue implementatio0n, Priority queue

Unit 4 Lists **9 hrs**

Definition, Static and dynamic list structure, Array implementation of lists, Queues as list, Linked list, Linked list as an ADT, Types of linked list: Singly linked list, Circular linked list, Doubly linked lists, Basic operations in linked list: node creation, node insertion, deletion at different location, implementation of stack and queue using linked list.

Unit 5 Recursion **3 hrs**

Principle of recursion, Comparison between recursion and iteration, Recursion example: Factorial, Fibonacci sequence, GCD and Tower of Hanoi (TOH), Applications of recursion

Unit 6 Sorting **7 hrs**

Introduction, Internal and external sorting, Insertion sort, Selection sort, Bubble sort, Merge sort and quick sort, Efficiency of sorting algorithm.

Unit 7 Searching and Hashing **5 hrs**

Introduction to searching, Search algorithm: Sequential search, Binary search, Efficiency of search algorithms, Hashing: hash function, hash table, Collision resolution techniques.

Unit 8 Trees **6 hrs**

Concepts of tree, Basic operation in binary tree, Tree height, level and depth, Tree search and insertion/deletions, Binary tree traversals (pre-order, post-order and in-order), AVL tree, Balancing algorithm.

Unit 9 Graphs **8 hrs**

Representation and applications, Graphs as an ADT, Graphs types, Transitive closure, Warshall's algorithm, Graph traversal, Minimum spanning tree: Kruskal's and Prims algorithms, Shortest path algorithm: Dijkstra's algorithm.

Laboratory Work:

After completing this course, students should be able to implement all the concepts of data structures and algorithms in the syllabus using C/Python programming language. The laboratory work should include at least following;

1. Implementation of Stack
2. Implementation of Linear and Circular Queues
3. Implementation of list and link list: Singly and Doubly
4. Factorial, Fibonacci and TOH using Recursion
5. Implementation of different Sorting Algorithms
6. Implementation of Searching Algorithms
7. Implementation of Binary and AVL tree.
8. Implementation of Tree Traversals
9. Implementation of Graph and its Traversal.

References:

1. Langsam, Y. , Augenstein, M.J. and Tenenbaum, A. M. , *Data Structures using C and C++* ,2nd edition.
2. Rowe, G. W. , *Introduction to Data Structure and Algorithms with C and C++*.
3. Rajesh K. Shukla, *Data Structures using* C & C++.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Macroeconomics** — *Code No*.: **BMS 254**
Nature: Theory — Credit: 3

Course Description:

The course covers Government, Markets and firms, International trade, Macroeconomic environment, Balance of payments and exchange rates, Money and interest rates, Business activity, Unemployment and inflation, Demand-side and supply-side macroeconomic policies.

Learning Objectives:

Upon successful completion of the course, the student will be able to introduce the core economic principles and how these can be used in a business environment to help decision-making and behavior. It provides the fundamental concepts of macroeconomics that explain how economic agents make decisions and how these decisions interact. It explores the principles underlying macroeconomics that explain how the economic system works, where it fails, and how decisions taken by economic agents affect the economic system.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Government, Markets and Firms **10 hrs**

Reasons for government intervention in the market, The extent to which businesses meet the interests of consumers and society in general, Perfect markets, Social efficiency, Externalities and inefficient markets, Ways and drawbacks of government intervention in markets, Taxation and regulation for correcting markets' shortcomings. Relationship between the government and individual firms, Targets of "competition policy", Extent to which competition policy is effective, Failure of a free market in achieving the optimal amount of research and development, and Various forms of intervention for encouraging technological advance and innovation. businesses meet the interests of consumers and society in general.

Unit 2 International Trade **6 hrs**

Globalization and multinational business, Impact of globalization on business, Driving force of globalization process, Importance of international trade, The growth of international trade and its benefits to countries and firms, Advantages of specialization, Trade restriction and protection of domestic industries, Role of the World Trade Organization (WTO) in international trade.

Unit 3 Macroeconomic Environment **8 hrs**

The macroeconomic environment of the business, Main macroeconomic variables that Bgovernments seek to control, Determining force for the business climate, Effect of stimulating the economy on business output, Actual and potential growths, Economic growths, Relationship between economic growth and environmental sustainability, Periods of boom and periods of recession in the economy, Determining factors which influence the length and magnitude of the phases of a business cycle, Causes and costs of unemployment, Unemployment and the level of business activity, The price level in the economy and a simple AS-AD model, Causes and costs of inflation, Inflation and the level of business activity, GDP and its measurement, Simple model of the circular flow of income representing the economy.

Unit 4 Balance of Payments and Exchange Rates **6 hrs**

Balance of payments and effect of trade and financial movements on it, Exchange rates, Effect of changes in exchange rates on business, Balance of payments and exchange rates, Advantages and disadvantages of fixed and floating exchange rates, Governments and/or central bank intervention on the exchange rates, Implications of such actions for other macroeconomic policies and business, Monetary union and single currencies concerning the European Economic and Monetary Union, Exchange Rate Mechanism and creation of a single currency. the role, structure, and stability of the financial system, the functions of the financial sector, the functions of investment funds, banks, and insurance companies/pension funds, and the different ways banks and insurance companies can be exposed to credit risk and liquidity risks through bank loans, corporate bonds, securitizations (owned by the non-bank sector), syndicated loans, credit derivatives.the banking sector is more likely to be exposed to systemic risk than the non-bank financial sector. financial innovation could lead to some functions of the banking sector being performed by non-banks.

Unit 5 Money and Interest Rates **6 hrs**

Role of money and interest rates in the economy, Function of money, Amount of money in economy and causes of its growth, Concept of money multiplier in the real world, Methods of determining interest rates, Money and interest rates, Role of central banks in the functioning of economies, The impact of change in the money supply and/or interest rates on the level of business activity, Role, structure, and stability of the financial system, Evaluation of different financial systems concerning the UK and China, Financial markets and a nation's objectives, Different participants in the financial markets, Development of financial systems, Factors affecting the stability of financial systems. The basic principles on which Islamic finance is based. The features of one Islamic finance product and compare its features to the principles of Islamic finance.

Unit 6 Business Activity, Unemployment and Inflation **4 hrs**

Level of business activity and its impact on unemployment and inflation, the Equilibrium level of income in a simple Keynesian model, Concept ofmultiplier and calculation of its value, Effect of a rise in money supply on output and prices, Unemployment and inflation, Business and consumer expectations, Policy of targeting inflation, Course of a business cycle and its turning points.

Unit 7 Demand-Side and Supply-Side Macroeconomic Policies **8 hrs**

***Demand-side Policy*:** Macroeconomic policy and its types, Fiscal policy and economic fluctuations, Fiscal rules, Monetary policy in the UK and the Eurozone, Roles of the Bank of England and European Central Bank, targeting inflation, Interest rates, and economic activity, Merits of following a simple inflation target as a rule for determining interest rates, the alternative rule to the inflation target.

***Supply-side Policy*:** Supply-side policy and its impact on businesses and economy, Types of supply-side policies that can be pursued and discuss their effectiveness, Impact on the business of a policy of tax cuts, Major types of policy open to governments to encourage increased competition.

References:

1. Hinde, J., K. and Garratta, D. Sloman, *Economics for Business*, 5th edition, Prentice Hall,2010
2. Begg, D. K. H.; Fischer, S.; Dombusch, R., *Economics*, 8th edition, McGraw-Hill,2005
3. Lipsey, R. G.; Chrystal, K. A., *Economics*, 11th edition, Oxford University Press,2007.
4. Mankiw, N.G.; Taylor, M P. Thomson, *Economics*, 2006.
5. Parian, M, Powell, M.; Matthews, K., *Economics*, 7th edition, Pearson Education,2007.
6. Sloman, J., *Essentials of Economics*, 4th edition, FT Prentice Hall,2006.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Risk Management** — *Code No*.: **BMS 255**
Nature: Theory — *Credit*: 3

Course Description:

This course covers nature of risk, identification and handling of risk, management of risk, enterprises risk and tools that are used to analyze corporate risk. It also deals with management and measuring in risk insurance.

Learning Objectives:

After the successful completion of this course the student will be able to

1. Provide depth knowledge of risk, its identification and management.
2. Provide techniques and tools used in corporate risk management.
3. Describe the concept of insurance and risk management in insurance company.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Introduction to Risk **4 hrs**

Terminology, Concepts and scope of risk management, Uncertainty and its relationship to risk, Measurement and degree of risk, Risk versus perils versus hazards, Classification of risk: financial and non-financial risk, dynamic and static risk, systematic and unsystematic risk, pure and speculative risk, fundamentals and particular risk and enterprises risk.

Unit 2 Identification and Handling of Risk **3 hrs**

Techniques of identification of risk, Methods of handling risk: avoidance, loss prevention and loss control, retention and self-insurance, non-insurance transfer, hedging, diversification and insurance.

Unit 3 Risk Management **10 hrs**

Definition, Tools, Objectives, Process, Levels and application of risk management, Risk management benefits, Risk management matrix, Rules of risk management, Risk management theory: classical risk theory, collective risk theory, and the modern risk theory, Risk managements' contribution to the organization.

Unit 4 Enterprises Risk Management **10 hrs**

Introduction to enterprise risk management**,** Risk and opportunities**,** Benefits of enterprises risk management program**,** Loss forecasting**,** Financial analysis in risk management decision, Other risk management tools, COSO framework for enterprise risk management: components, benefits, limitation. Emerging role of chief risk officer (CRO),Enterprise risk management process.

Unit 5 Analysis Tools used in Corporate Risk Management 4 **hrs**

Risk management tools, Calculation of frequency and severity of loss, Correlation analysis, Time value of money and use of discounted cash flow, Net present value and internal rate of return, Assets and liability management, Probability and its use in insurance, Risk reduction through pooling.

Unit 6 Risk Perception, Culture and Human Behavior 4 **hrs**

Human behavior factors and risk perception, Leadership and risk culture, Measuring risk management performance and improving risk management performance.

Unit 7 Risk Management in Insurance Companies **3 hrs**

Model of risk management, Risk management in life insurance**,** non life insurance and reinsurance, Position of risk manager in insurance companies, Insurance risk management system, Risk management practices by insurers in Nepal.

Unit 8 Emerging Issues and Trends to Risk Management **10 hrs**

Global warming and climate change, Cyber security risk, Aurospace and space shuttle risk, Catastrophic risk, Disaster risk and its management.

References

1. George Rejda, *Principles of Risk Management and Insurance*, Pearson Education.
2. Arthur, C., William Jr., Michel Smith, Peter Young, *Risk Management and Insurance*, McGraw-Hill.
3. Gupta, P.K., *Insurance and Risk Management*, Himalayan Publishing House.
4. Harrington Scott E., Niehaus Gregory R., *Risk Management and Insurance*, McGraw-Hill
5. Teale John, *Insurance and Risk Management*, McPherson.
6. Passenheim Olaf, *Enterprise Risk Management*, Ventus Publishing.
7. Vaughan Emmett J., Vaughan Therese M., *Fundamentals of Risk and Insurance*, R.R., Donnelley.
8. Harold D. Skipper, W. Jean Kwon, *Risk Management and Insurance*: Perspectives in a Global Economy, Wiley-Blackwell.

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Tribhuvan University
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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences | *Full Marks*: 25
Paper: **Actuarial Seminar II** | *Code No.*: **BMS 256**
Nature: Practical | *Credit*: 1

Course Description:

This course is the continuation of the course Actuarial Seminar I and covers knowledge related problems that actuaries work in industry. The instructor helps the students in doing the seminar about the skills needed to pass actuarial exams.

Learning Objectives:

After successful completion of this course the student will be able to

1. Prepare the students with good ideas of current actuarial practice in related industry;
2. Impart the principles of mathematical, statistical, and probability in risk analysis;
3. Provide the students with actuarial skills, career information and professional exam .

Mode of Delivery:

The seminar will be conducted by class discussion and presentation to make active participation of students that concentrates on actuarial issues .The experts/ actuaries may use the actuarial software in class discussion and computers/laptops will be encouraged.

Course Contents:

Seminar should focus on a well-formulated research question related to actuarial analysis, financial planning, investment analysis, underwriting, risk analysis, etc. encouraging group discussions and creative assignments.

The following activities and steps will be involved in the presentation of the seminar:

- Selecting a relevant topic or issue or problem related to actuarial analysis, financial planning, investment analysis, underwriting, risk analysis, etc for the study;
- Receiving approval from the faculty to pursue the proposed topic;
- Finding the related literature;
- Locating the sources of data and information;
- Extracting the relevant information from different sources (Student may use the actuarial software); and drawing conclusions.

Seminar Evaluation Guidelines:

Final examination of the seminar is evaluated by committee of the faculties/experts (appointed by the school) by taking the oral presentation(individual/group) and viva in a relevant topic or issue related to actuarial analysis, financial planning, investment analysis, underwriting, risk analysis, etc on the prescribed evaluation format prepared by the school. The evaluation format includes the quality of the seminar paper prepared by students and its relevancy, depth of work, presentation skill and response of query.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Discrete Mathematics** — *Code No.*: **BMS 301**
Nature: Theory — *Credit*: 3

Course Description:

This course deals with mathematical structures that are discrete in nature rather than continuous. Its core area is combinatorics. It covers the key combinatorial topics of combinatorial enumeration and is useful and accessible for applied fields. It has many real-world applications that can be explained using only a few simple definitions. Elementary number theory, Modular arithmetic, Induction, Counting techniques, Recurrence relations, Graph and trees are key topics treated in a way that will facilitate the students in being able to think logically and mathematically, and finally making them capable of applying the techniques of discrete mathematics in solving problems.

Learning Objectives:

After successful completion of this course the student will be able to

1. Use Modular arithmetic
2. Work with prime numbers and the fundamental theorem of arithmetic,
3. Solve systems of linear congruences and counting problems.
4. Work with encoding and decoding
5. Apply the principles of mathematical induction in proofs.
6. Model with recurrence relations
7. Use graph models

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Number Theory 8 hrs

Integers and division, Modular arithmetic, Primes and greatest common divisors, Congruences, Applications of number theory (Cryptography).

Unit 2 Induction and Recursion 10 hrs

Mathematical induction, Strong induction and well-ordering, Recursive definitions and structural induction.

Unit 3 Counting 8 hrs

Basics of counting, Pigeonhole principle, Permutations and combinations, Binomial coefficients and identities, Generalized permutations and combinations.

Unit 4 Recurrence Relations and their Applications 12 hrs

Recurrence relations, Recursion and iteration, Modeling with recurrence relations, Solving linear homogeneous recurrence relations with constant coefficients, Linear non homogeneous recurrence relations with constant coefficients, Generating functions, Inclusion-exclusion.

Unit 5 Graph Theory 10 hrs

Graphs and graph models, Graph terminology and special types of graphs, Representing graphs and graph isomorphism, Connectivity, Shortest-path problems, Introduction to trees, Applications of trees, Spanning trees, Minimum spanning trees

References:

1. Kenneth H. Rosen, *Discrete Mathematics and its Applications* ,8th edition, McGraw Hill, New York.
2. Susanna S. Epp, *Discrete Mathematics with Applications,* Brooks/Cole ,2011.
3. Kevin Ferland, *Discrete Mathematics an Introduction to Proofs and Combinatorics*, Houghton Mifflin Company, 2009.
4. Peter J. Cameron, *Combinatorics: Topics, Techniques, Algorithms,* CUP, 1995.
5. Dieter Jungnickel, *Graphs, Networks, and Algorithms,* Springer, 2005.
6. Ian Anderson, *A First Course in Discrete Mathematics*, Springer, 2001.
7. Alan Camina and Barry Lewis , *An Introduction to Enumeration*, Springer, 2011.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Actuarial Mathematics II** — *Code No*.: **BMS 302**
Nature: Theory — *Credit*: 3

Course Description:

This course is a grounding in the principles of modeling as applied to actuarial work focusing particularly on deterministic models which can be used to model, and value known cash flows as well as those which are dependent on death, survival, or other uncertain risks.

Learning Objectives:

On the successful completion of this subject, the student will be able to

1. Describe, interpret, and discuss the theories on interest rates

2. Describe, interpret, and discuss the equation of value and its application

3. Describe, interpret, and discuss the life table for mortality and morbidity

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Assurance and Annuity Functions **12 hrs**

Define life assurance and annuity contracts, Means and variances of the payments under various assurance and annuity contracts, Variable benefits and conventional with-profits contracts, Cash flows dependent upon the death or survival of either or both of two lives, functions dependent upon a fixed term as well as age.

Unit 2 Expected Cash Flows Contingent upon Multiple Decrement Events **6 hrs**

Valuing cash flows that are contingent upon multiple transition events, Construction and use of multiple decrement tables, projecting and valuing expected cashflows that are contingent upon multiple decrement events, A multiple decrement model as a special case of multiple-state Markov model, Forces of transition, Dependent probabilities for a multiple decrement model in terms of given forces of transition.

Unit 3 Pricing **10 hrs**

The gross premium, Gross future loss random variable, Principle of equivalence, Determining gross premiums using the equivalence principle, Calculating gross premiums using simple criteria other than the equivalence principle, calculate premiums for policies involving two lives.

Unit 4 Reserving **11 hrs**

Gross Premium Reserves, Prospective and retrospective reserves, Equality of prospective and retrospective reserves, Recursive relationships between successive periodic gross premium reserves, Net premium reserves for conventional without profit contracts, calculate premiums for policies involving two lives, Calculation of death strain at risk, calculation of single policy or portfolio of policies, expected death strain, actual death strain, mortality profit.

Unit 5 Cash flow Projection and Profit Test **9 hrs**

Conventional unit-linked contracts, and accumulating with-profits contracts, Projection of expected future cash flows for various types of insurance (whole life, endowment assurance and term assurances, annuities, Profit test model and its use, Determine the profit vector, the profit signature, the net present value and the profit margin, Reserving aspects of profit testing.

References:

1. ActEd Study Material Subject CT1, Actuarial Education Company, 2019
2. Kellison, *The Theory of Interest*, Irwin Mc-Graw Hill, 2006
3. Bowers, L. Newton, *Actuarial Mathematics*, Society of Actuaries, 2006.
4. McCutcheon, J. J.; Scott, W. F. Heinemann, *An Introduction to the Mathematics of Finance*, Institute and Faculty of Actuaries' Online Publications Shop, 1986.
5. Mark S. Joshi , *The Concepts and Practice of Mathematical Finance*, Cambridge University Press, 2008
6. Paul Wilmott, Sam Howison and Jeff Dewynne, *The Mathematics of Financial Derivatives*, Cambridge University Press, 1995.
7. Ross, S. M, *An introduction to Mathematical Finance*, Cambridge University Press.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences | *Full Marks*: 75
Paper: **Excel for Actuarial Mathematics** | *Code No.*: **BMS 303**
Nature: Theory and Practical(1+2) | *Credit*: 3

Course Description:

Actuarial Mathematics provides a grounding in the principles of actuarial modelling, focusing on deterministic models and their application to financial products. It equips the student with a knowledge of the basic principles of actuarial modelling, theories of interest rates and the mathematical techniques used to model and value cashflows which are either certain or are contingent on mortality, morbidity and/or survival. The subject includes application of the ideas to real data sets using Microsoft Excel. The course focuses on computational aspects of actuarial modeling and analysis, covered by BMS 252 Actuarial Mathematics I and BMS 302 Actuarial Mathematics II. It covers the fundamental syntax and object types used across all aspects of Excel programming.

Learning Objectives:

After the successful conclusion of this course, the student will be able to

1. Use the basic principles of actuarial modeling in Excel.
2. Use theories on interest rates in Excel.
3. Model and value cashflows that are contingent on mortality and morbidity risks in Excel.

Mode of Delivery:

The course will be taught by implementing interactive teaching methods using computer technologies in the class room. There will be a project and students will prepare a model as per the instructor/lecturer.

Course Contents:

Unit 1 Introduction to Excel **3 hrs**

Basic Excel operations and tasks, Excel functions, Excel charts, Other useful Excel features, Guidelines for Excel, Pitfalls with Excel, and Descriptive data analysis.

Unit 2 Theory of Interest Rates **12 hrs**

Time value of money, Interest rate: Simple and compound, Rate of interest payable p times per measurement period, real and money interest rate, Discounting and accumulations of cashflows, Annuities,Term structure of interest rates, Discrete and continuous rates, Asset liability management: Duration, convexity, immunization of cash flows and Redington's conditions of immunizations.

Unit 3 Equation of Value and its Applications **9 hrs**

Equation of value,Uses of equation of value: Loan schedules, price or yield of financial instruments, and Project appraisal: Net cash flow, Net present value, Accumulated profit, Internal rate of return, Payback period, discounted payback period.

Unit 4. Pricing and reserving **12 hrs**

Principle of equivalence, Determining gross premiums using the equivalence principle, Pricing in the context of Nepal, Sensitivity tests, Gross Premium Reserves, Prospective and retrospective reserves, Equality of prospective and retrospective reserves, Recursive relationships between successive periodic gross premium reserves, *Calculat*ion of death strain at risk, calculation of single policy or portfolio of policies, expected death strain, actual death strain, and mortality profit.

Unit 5. Cash flow Projection and Profit Test **12 hrs**

Life Tables, Multiple decrement models, Conventional unit-linked contracts, Projection of expected future cash flows for various types of insurance (endowment assurance and term assurances, temporary annuities), Profit test model and its use, Determine the profit vector, the profit signature, the net present value and the profit margin, Reserving aspects of profit testing.

References

1. Kellison, *The Theory of Interest*, Irwin Mc-Graw Hill, 2006.
2. Bowers, L. Newton, *Actuarial Mathematics*, Society of Actuaries, 2006.
3. Mark S. Joshi,*The Concepts and Practice of Mathematical Finance*, Cambridge University Press, 2008.
4. McCutcheon, J. J.; Scott, W. F. Heinemann, *An Introduction to the Mathematics of Finance*, Institute and Faculty of Actuaries' Online Publications Shop, 1986.
5. Ross, S. M., *An introduction to Mathematical Finance*, Cambridge University Press.
6. Dickson, D.C.M.; Hardy, M.R.; Waters, H.R., *Actuarial mathematics for Life Contingent Risks*, 3rd edition, Cambridge University Press, 2020.
7. Kellison, S. G. ,*The theory of interest*, 3rd ed. McGraw-Hill-Irwin, 2008.
8. Promislow, D. ,*Fundamentals of actuarial mathematics*, 3rd ed. John Wiley, 2015.
9. Wilders. R.J., *Financial Mathematics for Actuarial Science*, CRC Press, 2020.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75

Paper: **Research Methodology** — *Code No*.: **BMS 304**

Nature: Theory — *Credit*: 3

Course Description:

The course has a preliminary focus on problem identification, theoretical framework development, and hypothesis formulation. The course will then deal with research design issues, measurement, sampling, data collection, and analysis. This encompasses the overall understanding and application of appropriate research techniques and research statistics, and report writing and presentation skills.

Learning Objectives:

The objective of this course is to make students familiar with research techniques in actuarial sciences. After completion of this course, the students will be able to carry out research work independently.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Introduction **8 hrs**

Concept and types of research, Process, and characteristics of scientific research, Emerging paradigms in research: quantitative and qualitative, positive normative, and interpretive paradigms, Relations between research approaches and research methodologies, Business research: types, value for decision making, Ethical considerations in research.Concept, Features, and assumptions of Qualitative research, Common practices in qualitative research, Methods of qualitative research: Case study, Grounded theory, and phenomenological study, Strength of qualitative research.

Unit 2 Stages of Research Process **7 hrs**

Literature Review:purpose and steps; Searching, obtaining, and evaluating the literature;Literature search through the Internet; Format and guidelines for presenting the literature review.Theoretical framework, conceptual framework, Operational definition:Conceptand need for research; Research and theory: deduction and induction; Contributions of research to theory building and practice.Problem definition**:** concept and steps in problem formulation; Research questions, concept and types. Propositions and hypotheses formulation: Concept of proposition; Functions of hypotheses; Types: descriptive, relational, directional, explanatory, and null hypotheses; Criteria of the good hypothesis statement.

Unit 3 Research Designs **7 hrs**

Elements of a research design; Classification of research designs: exploratory; descriptive; developmental; case study; causal-comparative and experimental research designs; Common sources of error.

Unit 4 Measurement, Scaling, and Sampling **8 hrs**

Variables- concept and types; Scales of measurement; Attitude measurement and scale construction; Attitude scales commonly used in social science research; Criteria of good measurement-validity and reliability of measurement; Sources of measurement problems;

Sampling-concept and process; Population and sampling; Types of sampling-probability and non-probability sampling; Sampling and non-sampling errors.

Unit 5 Data Collection and Analysis **8 hrs**

Data and its types; Sources of primary and secondary data; Important considerations for data collection; Questionnaire- principles, components, and types; Research interview-types and process; Sources of qualitative data- observation and their types, focus groups; Use of the Internet for data collection; Data analysis- Data processing; Presenting data in graphs and tables; Statistical analysis of data descriptive and inferential statistics; Hypothesis testing; Methods of analyzing qualitative data-content, thematic and narrative analysis.Data analysis - quantitative; time series, cross-section, pulled and panel data, and interoperation of the results.

Unit 6 Writing Proposals and Research Reports **10 hrs**

Functions and types of research proposals: solicited and unsolicited proposals; Structure and contents of academic and funded research proposals. Research reports- concept, process, types, and procedure for writing a research report; Conventions of academic writing; Pre-writing concerns; Components of the research report; Body of the project; Documenting sources- APAstyle of citation and referencing(7^{th}Revised edition -2022); Evaluation of research reports; Essentials of the good research report.

References:

1. Zikmund, W. G. ,*Business Research Methods*, Thompson, New Delhi, India.
2. Cooper, D. R., and Schindler, P. S. , *Business Research Methods*. Tata McGraw Hill, New Delhi.
3. Bryman, A. and Bell, E. ,*Business Research Methods*, Oxford University Press, New Delhi.
4. Uma, S. and Roger, B., *Research Methods for Business: A Skill-Building Approach*. John Wiley and Sons, Ltd., Publication.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks: 75*

Paper: **Financial Engineering and Loss Reserving I** — *Code No.:* **BMS 305**

Nature: Theory — *Credit: 3*

Course Description:

This subject introduces students to stochastic asset liability modelling. It aims to expand the student's knowledge of basic actuarial principles in the fields of investments and asset management.

Learning Objectives:

On successful completion of this subject, the student will be able to

1. Describe, interpret and discuss financial economics, and asset and liability models.
2. Deploy established approaches accurately to analyze and solve problems using a basic level of skill in calculation and manipulation of financial economics, and asset and liability models
3. Discuss recent developments in financial economics and establish the links between the theory of these topics and their practical application

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Rational Expectations Theory **3 hrs**

Concepts of market efficiency and rationality, Different forms of the efficient markets hypothesis and their consequences for investment management, Evidence for or against each form of the efficient markets hypothesis.

Unit 2 Utility Theory and Behavioral Economics **10 hrs**

Axioms underlying utility theory and the expected utility theorem, Investor characteristics, Utility functions and their economic properties, Kahneman and Tversky's prospect theory, Critique of expected utility theory, Framing, heuristics and bias in the context of financial markets, Findings of behavioral finance, Bernartzi and Thaler solution to the equity premium puzzle.

Unit 3 Measures of Investment Risk **6 hrs**

Properties of risk measures, Relation with the form of an investor's utility function, Use of risk measures in comparing investment opportunities, Influence of the distribution of returns and the thickness of tails on the assessment of risk, Measures taken by insurance companies to reduce or remove risk. Moral hazard and adverse selection.

Unit 4 Stochastic Interest Rate Models **4 hrs**

Stochastic models for investment returns, Use of stochastic investment return models to compute accumulated amount in case of single premium and annual premium, Lognormal distribution and its application in modelling investment returns, Probabilistic evaluation of payments accumulation.

Unit 5 Portfolio Theory and Asset Pricing Models **10 hrs**

Assumptions of Modern Portfolio Theory (MPT), Application of MPT for optimum portfolio selection, Application of MPT for computing expected return and risk of a portfolio of many risky assets, Diversification and its benefits. Single-index model and Multifactor models of asset returns, Diversifiable and non-diversifiable risk. Assumptions, uses and limitations of Sharpe-Lintner-Mossin Capital Asset Pricing Model (CAPM), Estimation of parameters for asset pricing models.

Unit 6 Liability Valuations **15 hrs**

Ruin Theory: Aggregate claim process, Cash-flow process for a risk, Poisson process and distribution of inter-event times, Compound Poisson process and its use, Probability of ruin in infinite/finite and continuous/discrete time, Relationships between the different probabilities of ruin, Effect on the probability of ruin of changing parameter values, and Probabilities of ruin by simulation, Run-off Triangles: Development factor and it's use to project the future development of a delay triangle, Basic chain ladder method and its application, Inflation adjusted chain ladder method, Average cost per claim method, Bornhuetter-Ferguson method, Underpinning a run off triangles approach using a statistical model, Value basic benefit.

References:

1. Act Ed Study Material Subject CM2, Actuarial Education Company.

2. Panjer, Harry H (ed), *Financial Economics: with Applications to Investments, Insurance and Pensions*, The Actuarial Foundation, 2001.

3. Elton, Edwin J, Martin J Gruber, Stephen J Brown et al, *Modern Portfolio Theory and Investment Analysis* (8th edition), John Wiley, 2010.

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SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks: 75*
Paper: **Financial Engineering and Loss Reserving II** — *Code No.:* **BMS 351**
Nature: Theory — *Credit: 3*

Course Description:

This course is an introduction to Stochastic Calculus and its application to modern finance. The core topics developed in the course are the Ito stochastic integral, Ito's formula, and basic stochastic differential equations. The course will provide students with indispensable tools for valuing financial derivatives and for keeping up with developments in financial modeling.

Learning Objectives:

After the successful completion of this course, the student should be able to:

1. Have an understanding of some probability concepts to solve problems using sigma-algebras, probability measures, random variables, distributions and expectations of random variables
2. Construct and apply martingales in solving problems in finance and insurance
3. Have foundational knowledge of Brownian motion and geometric Brownian motion
4. Perform calculations with stochastic integrals and Ito's formula
5. Understand and apply the Black-Scholes PDE and formula for option pricing
6. Understand different approaches to modelling credit risk and credit ratings
7. Understand models of the term structure of interest rates and apply them to price basic interest rate derivatives.

Mode of Delivery:

The course will be taught by lecture method, problem solving and class discussion. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Stochastic Models for Security Prices and Ito's Lemma **12 hrs**

Standard Brownian motion, Wiener process, Stochastic differential equations, Ito integral, Diffusion and Mean-reverting processes, Statement of Ito's Lemma and its application, Stochastic differential equation for the geometric Brownian motion and Ornstein-Uhlenbeck process, Continuous time log-normal model of security prices and empirical evidence for and against the model.

Unit 2 Models of Term Structure of Interest Rates **8 hrs**

Principal concepts, characteristics and applications of term structure of interest rates models, Risk-neutral and state-price deflators approach to the pricing of zero-coupon bonds and interest-rate derivatives, Vasicek, Cox-Ingersoll-Ross and Hull-White models for the term-structure of interest rates, Limitations of one-factor models.

Unit 3 Derivative Contracts and Options Theory **6 hrs**

Arbitrage and a complete market, Derivative contracts: forwards and options. European and American call and put options, Valuing basic derivative contracts, Put-call parity, Upper and lower bounds for European and American call options, Option Greeks, Factors affecting option prices.

Unit 4 Models for Credit Risk **6 hrs**

Credit event and recovery rate, Approaches to modelling credit risk: Structural models, reduced form models, and intensity-based models, Merton model, Two-state model for credit ratings with a constant transition intensity, Jarrow-Lando-Turnbull model for credit ratings, Generalization of the two-state model to incorporate stochastic transition intensity.

Unit 5 Option Pricing **16 hrs**

Use of binomial trees and lattices in valuing options, Risk-neutral pricing measure for a binomial lattice, Risk-neutral pricing approach to the pricing of equity options, Comparing the real-world and risk-neural probability measures, Approach to pricing using deflators and its application in simple models, Assumptions underlying Black-Scholes model and their validity, Derivation of Black-Scholes PDE, Option pricing using Black-Scholes model, Equivalent Martingale measure, Pricing and hedging a simple derivative contract using the martingale approach, The 5-step method: discrete and continuous time.

References:

1. Act Ed , Study Material Subject CM2, Actuarial Education Company.

2. Baxter, Martin & Andrew Rennie, *Financial Calculus; An Introduction to Derivative Pricing*, Cambridge University Press, 1996.

3. Hull, John C., *Options, Futures and other Derivatives* ,7th edition, Prentice Hall, 2008.

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Tribhuvan University
Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Investment Strategies and Portfolio Management** — *Code No*.: **BMS 352**
Nature: Theory — *Credit*: 3

Course Description:

This course begins with a broad overview of the investment environment and describes financial instruments and their markets. Then it deals with the risk and return of an individual asset as well as that of portfolios and the selection of the optimal portfolio. It also deals with how debt and equity securities are valued for investment decision-making purposes. It also presents the framework for analyzing the economy and the industry in which investments are made. Finally, it concludes by dealing with an analysis of the risk inherent in investment and its management.

Learning Objectives:

This course aims to provide students with the fundamental knowledge of investing in securities.Specifically, it aims at enabling students to understand the investment environment, estimate risk and return from the investment, appraise them to form a portfolio for investment and analyze the economy and the industry in which they invest. Furthermore, this course also aims to develop risk analysis and management skills in students.

Mode of Delivery:

The course will be taught by discussion method and problem solving method. Students will be encouraged to utilize the computer whenever possible and wherever applicable.

Course Contents:

Unit 1 Investment and its Environment **6 hrs**

Concept of investment, investments – real and financial. Investors classes: institutional and individual. Influence of financial institutions on the investment environment. Role of regulators in the investment environment. Securities exchange act, securities listing bylaw, securities trading mechanism, and the rise of electronic trading.

Unit 2 Investment Instruments **8 hrs**

Financial instruments available for short-term lending and borrowing. Corporate and government debt securities, equity securities. Valuations of debt and equity securities. Yield calculations. Assets securitization, mortgage- and asset-backed securities. Currency as an investment tool. Stock and bond market indices.

Unit 3 Investment Risk and Return Analysis **6 hrs**

Measuring investment return: holding period return, annualized return, investment return over multiple periods, time series returns, probability distribution and expected return, and return of a portfolio. Measuring risk: variance, standard deviation, coefficient of variation of individual securities and portfolio.

Unit 4 Portfolio Management **12 hrs**

Diversification and portfolio risk; Asset allocation with two risky assets; Covariance and correlation; The risk-return trade-off with two-risky-assets; The mean-variance criterion; Theoptimal risky portfolio with a risk-free investment; Efficient diversification with many risky assets; The efficient frontier of risky assets; Choosing the optimal risky portfolio. Portfolio performance evaluation using benchmark: published index, pre-determined benchmark portfolio. Risk-adjusted performance measure.

Unit 5 Macroeconomic and Behavioral Effect on Investment **8 hrs**

Domestic macroeconomy; Government policy: fiscal policy and monetary policy; business cycles; Economic indicators; Industry analysis: defining an industry, sensitivity to the business cycle, sector rotation, industry lifecycles, and industry structure and performance.

The behavioral critiques: information processing, behavioral biases, bubbles and behavioral economies, evaluating behavioral critiques. Technical analysis and behavioral finance: trends and corrections.

Unit 6 Managing Risk in Investment **8 hrs**

Interest rate risk on a bond investment. Duration. Passive investment strategy: immunization bond and bond portfolio. Risk management by using derivatives: protecting portfolio using put option, foreign currency risk management by using futures and forward, interest rate risk management by using swap. Credit default swap in risk management.

References

1. Bodie, Z., Kane, A & Marcus, A., *Essentials of Investments*, New York: McGraw-Hill, 2021.
2. Alexander, G. J., Sharpe, W. F. & Bailey, J. V., *Fundamentals of Investments*, New Delhi: Prentice Hall of India Ltd.
3. Reilly, F. K. & Keith, C. B., *Investment Analysis and Portfolio Management*, New Delhi: Cengage Learning.

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Tribhuvan University
Institute of Science and Technology
SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program : Bachelor in Mathematical Sciences *Full Marks*: 75
Paper : **Excel for Financial Engineering and Loss Reserving** *Code No*.: **BMS 353**
Nature : Theory and Practical (1+2) *Credit*: 3

Course Description:

Financial Engineering and Loss Reserving provides a grounding in the principles of actuarial modelling, focusing on stochastic asset-liability models and the valuation of financial derivatives. It equips the student with a knowledge of the theories of behaviour of financial markets, measures of risk, determining reserves for a non-life insurer and price options. The subject includes application of the ideas to real data sets using Excel.

Learning Objectives:

After the successful conclusion of this course, the student will be able to use excel to

1. Interpret the theories on the behaviour of financial markets.
2. Apply and compare the measures of investment risk.
3. Interpret the models underlying asset valuations; liability valuations; and option pricing.

Mode of Delivery:

The course will be taught by implementing interactive teaching methods using computer technologies in the class room. There will be a project and students will prepare a model as per the instructor/lecturer.

Contents:

Unit 1 Theories of Financial Market Behavior 4 hrs

Utility function, Economic characteristics of investors mathematically expressed in a utility function, Utility functions to compare investment opportunities, Conditions for absolute dominance and for first- and second-order dominance, Insurance problems in terms of utility theory.

Unit 2 Measures of Investment Risk 6 hrs

Risk measures: Variance of return, Downside semi-variance of return, Shortfall probabilities, Value at Risk (VaR), and Tail VaR, Risk measures and form of utility function, Use of risk measures to compare investment opportunities.

Unit 3 Stochastic Interest Rate of Return Models 6 hrs

Mean and variance of the accumulated amount of a single premium. Recursive relationships for the evaluation of the mean and variance of the accumulated amount of an annual premium, Application of lognormal distribution in modelling investment returns, Probabilistic evaluation of payments accumulation.

Unit 4 Asset Valuations 10 hrs

Application of Mean-variance portfolio theory for computing expected return and risk of a portfolio of many risky assets, Diversification and its benefits, Single-index model and Multifactor models of asset returns, Estimation of parameters for asset pricing models, Properties of Brownian motion and stochastic models for security prices, Models of term structures of interest rates and its application in modelling various cashflows, including calculating the sensitivity of thevalue to changes in the term structure, Credit risk models: the Merton model, Two-state model for credit ratings, the Jarrow-Lando-Turnbull model for credit ratings.

Unit 5 Liability Valuations **12 hrs**

Ruin theory: Poisson process and the distribution of inter-event times to calculate probabilities of the number of events ina given time interval and waiting times, Compound Poisson process and calculation of probabilities using simulation, Probability of ruin in infinite/finite and continuous/discrete time and state, and explain relationshipsbetween the different probabilities of ruin, Calculation of probabilities of ruin by simulation, and Effect on the probability of ruin, in both finite and infinite time, of changing parameter values by simulation, Run-off triangles: Calculate development factors and use them to project the future development of a delay triangle, Allowance for inflation, Basic chain ladder, Average Cost per claim and Bornhuetter-Ferguson method for estimating outstanding claim amounts.

Unit 6 Option Theory **10 hrs**

Arbitrage, Forward contracts, Options, Lower and upper bounds for American and European options, Put-Call parity, Factors affecting option prices, Construction of binomial trees and lattices and using them to value options, State-price deflator approach to pricing, Black-Scholes derivative pricing model.

References:

1. Act Ed , *Study Material Subject* CM2, Actuarial Education Company.

2. Baxter, Martin & Andrew Rennie, *Financial calculus*; *An Introduction to Derivative Pricing*, Cambridge University Press, 1996.

3. Hull, John C, *Options, Futures and other Derivatives* ,7th edition), Prentice Hall, 2008.

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Tribhuvan University
Institute of Science and Technology

SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program: Bachelor in Mathematical Sciences — *Full Marks*: 75
Paper: **Compliance Law** — *Code No*.: **BMS 354**
Nature: Theory — *Credit*: 3

Course Description:

This course introduces the banking system, regulations and regulators of the banking system in Nepal. It also includes the laws and regulations and the regulator of the insurance industry of Nepal. Furthermore, students will also learn about the rules and legal procedures related to the capital and money markets of Nepal.

Learning Objectives:

After the successful conclusion of this course, the student will be able to

1. Know the legal environment of the banking system in Nepal.
2. Gain an understanding of insurance companies and their regulations in Nepal.
3. Understand laws and regulations regarding the money and capital market of Nepal.

Mode of Delivery:

The course will be taught by discussion method and case study method. Students will be encouraged to utilize the computer and internet to collect the latest information whenever possible and wherever applicable.

Course Contents:

Unit 1 Financial Institutions and Their Formation **4 hrs**

Formal and informal financial sector, Components of the formal financial system, Financial institutions, Financial markets, Financial instruments, Financial services, Classification and of financial institutions in Nepal, Interaction among financial components, Functions of a financial system. Formation of financial institutions under company act and related acts.

Unit 2 Regulation of Banking **12 hrs**

Regulation and supervision of banks and financial institutions by NRB, Nepal Rastra Bank Act 2058, Bank and Financial Institution Act (BAFIA) 2073, Banking Offense and Punishment Act 2064, Anti-Money Laundering Act, Foreign Exchange Act 2019, Bank merger and acquisition by-law 2073, capital adequacy regulation, Financial sector reforms, Central bank and monetary policy of Nepal.

Unit 3 Regulation of Insurance **8 hrs**

Overview of the insurance industry of Nepal: life and non-life insurance. Nepal Insurance Authority: role and functions. Insurance Act 2079, Insurance Regulation 2049 (updated 2070),Governance issues and challenges, Development of insurance lawsin Nepal, Challenges of compliance to insurers and regulator, Insurance licensing policy, Claim procedures and claim settlement, The semi-judiciary role of NIA in claim settlement,Compliance based regulation and risk-based regulation, Onsite and off-site regulations, The need of regulation insurance companies, Federal vs state regulation, Areas of regulation.

Unit 4 Directives Issued by Nepal Insurance Authority **8 hrs**

Corporate governance directives, Internal audit directives, Risk-based capital and solvency directives, Directives related to merger and acquisition, Insurer registration and operation directive, Policy directive, Actuarial valuation directive, Risk management guidelines, Investment directives, AML/CFT directives, Claim settlement guidelines, Financial statements related directive, Reinsurance directive. Investment directive, Money laundering directive, and Insurance agent directive.

Unit 5 Money Market and Related Laws 6 hrs

Nepalese money market, Role of NRB in the money market, Money market instruments in Nepal: Treasury bills-feature, Types, Importance, Participants in the T-bill market, Sale of T-bills, Implicit yield, Commercial bills, Certificate of deposits, Call money market, Money market derivatives and participants, Issues in money markets in Nepal, Open market operation by-law of NRB, T-bill issue procedure.

Unit 6 Capital Market and Related Laws 10 hrs

Evolution of Nepalese stock market, Primary markets: Pricing of primary securities, Public issue, Further public issue, Private placement and right issue, Regulatory provisions on primary issues, Secondary market: Functions and types, Primary markets versus secondary markets, Organization, management and membership of Nepal Stock Exchange, Securities listing by-law 2075, Stock market index, OTC market, Stock market regulation and Nepal Securities Board, Securities act 2063, Commodities act 2073, Securities registration and issue regulation 2079, Mutual fund regulation 2067. Debt market**:** Government and corporate debt securities market, Government bond issue procedure, Treasury securities, Primary and secondary issue management by-law 2061.

References:

1. Pathak, B., *Indian Financial System: Market, Institution and Services*, Pearson Education India.
2. Kohn, Meir, *Financial Institutions and Markets*, Tata McGraw-Hill, Delhi.
3. M. Y. Khan, *Financial System in India*: Delhi: McGraw Hill Education India.
4. Saunders, A. & Cornett, M. M., *Financial Markets and Institutions*, New York: McGraw Hill Irwin.
5. Rejda, G.E., *Principles of Risk Management and Insurance*, Noida(U.P): Pearson India Education Services Pvt Ltd.
6. Publications of Nepal Rastra Bank, Securities Board of Nepal, Beema Samati, Nepal Stock Exchange.
7. Regulations governing the respective markets and institutions.
8. Department of Cooperatives, Static of Cooperatives in Nepal, 2012
9. Department of Cooperatives, Model By-laws of Cooperatives, 1992.

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Tribhuvan University
Institute of Science and Technology
SCHOOL OF MATHEMATICAL SCIENCES

Course of Study

Program : Bachelor in Mathematical Sciences — *Full Marks*: 100
Paper : **Actuarial Project Work** — *Code No*.: **BMS 355**
Nature : Practical — *Credit*: 4

Project Guidelines

Course Description:

This course aims to assist students to showcase their actuarial knowledge and skills into practicality as well as apply it in the real world. There will be faculty supervisors helping the students in doing the project work to write a report.

Learning Objectives:

This course provides the students an opportunity to work on a specific area in Actuarial Science in which they are interested in taking up a specific problem. By the end of the course, the students will be able to

1. Carry out scientific research on any area in Actuarial Science and related subjects.
2. Design and carry out research and analyse data using any software package.
3. Write a detailed report of the scientific research carried out.

Stages of Evaluation and Criteria:

1. **Proposal Defense** (At the beginning):10% weight

Topic selection	Response of query	Total
5% of total	5% of total	10%

2. **Mid-Term Progress Report** (After 3 month)**:**30% weight

Problem design and Depth of work	Presentation skill	Response of query	Total
15% of total	5% of total	10% of total	30%

3. **Final Presentation and Viva** (After Completion of Project):60% weight

Depth of work	Analysis, design, documentation and overall project report	Scope of the project and implementation	Presentation skill	Response of query	Total
10% of total	20% of total	10% of total	10% of total	10% of total	60%

Proposal and mid-term progress report defense will be evaluated by Project Evaluation Committee formed by SMS TU. Final defense will be evaluated by External Examiner (50% marks) and Project Evaluation Committee (50% marks).Project supervisor shall be the faculty member of the school. The project can be co-supervised by the other university faculty relevant to the project work. External examiner shall be appointed by the Examination Section, Office of the Dean, Institute of Science and Technology in consultation with the Director of SMSTU.

Proceeding

a. Proposal submission

-Student(s) prepares proposal in the prescribed format and defense to the Project Evaluation Committee.

-If the proposal is accepted; a supervisor is assigned by Project Evaluation depending upon the nature of the project.

b. Mid term progress report defense

- Project Evaluation Committee should manage a mid-term progress report defense after first 40% to 60% of the project duration.

c. Final defense

- Student(s) submits a complete project report in the prescribed format to the Project Evaluation Committee. The committee then schedules the day for final defense.

Format of the Proposal

1. Introduction
2. Problem statement (Why have you chosen this topic?)
3. Objectives
4. Scope and limitation
5. Methodology
   a. Requirement identification
   b. Feasibility study
   c. Tools used
6. Chart to show the projected time planning
7. Expected outcome

Format of the Project Report

The sequence in which the project report material should be arranged is as follows:

1. Cover page and title page
2. Certificate page
   i. Declaration from the student ii. Supervisor's certificate iii. Examiner's approval sheet
3. Abstract page
4. Acknowledgement
5. Table of contents
6. List of symbols, figures & tables
7. Main report
8. Appendices (Screen shots, source code snap shots)
9. References and bibliography

Description

1. Cover Page & Title Page: Title, name of the candidate and university roll no., name of supervisor, school name (and logo) with university name and month and year of submission.
2. Supervisor's Certificate: It certifies that the student has carried out the project work presented under his/her supervision. It approves that the project work embodies result of original work and studies carried out by the student himself and the contents of the project do not form the basis for the award of any other degree to the candidate or to anybody else.
3. Internal, External Examiners' Approval: It approves the acceptance of the project work for the partial fulfillment of the award of the course.
4. Acknowledgement: The student may thank all those who helped in the preparation of project.
5. Abstract of the report should be not more than one page: It should include the purpose of the study, the methodology used and a summary of the major finding, conclusions and recommendations.
6. Table of contents should contain the title of the contents of the document and their respective page numbers.
7. Main Body of the Project: This is the major part of the project giving the detail of the project work. The project may be divided into chapters with suitable titles.
8. Appendices: Appendices are provided to give supplementary information, which is included in the main body. Appendices should be numbered using Arabic numerals, e.g. Appendix I, Appendix II, etc.
9. References should be arranged in the latest edition of APA format.

Prescribed Format for Chapters and their Arrangement in Main Report

1. Introduction of the project
2. Problem statement (a paragraph)
3. Literature review
4. Objective (written in bullet; can be up to 3 to 5 starts with "To..")
5. Research methodology
6. cope of the project
7. Requirement analysis and feasibility study
8. Implementation
9. Testing
10. Conclusion, lesson learnt and suggestions/ recommendations

The main heading outlined above will be divided into several divisions and sub-divisions as required.

Note: The Project Evaluation Committee can adjust / modify/ amend the structure/ format of the project report and its evaluation criteria.

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