

Secondary Education Curriculum

2076

Business Mathematics

Grades: 11 and 12

Subject code: Bmt. 405 (Grade 11), Bmt. 406 (Grade 12)

Credit hrs: 5

Working hrs: 160

1. Introduction

Business primarily revolves around the financial transaction or products that have some monetary value. Involvement of finance makes it extremely important to have sufficient knowledge about the basics of calculations. This is where business mathematics comes into play. It deals with the fundamental topics that one needs to carry out business related calculations. Realizing the necessity to impart the same on students, the curriculum has been developed for Grades 11 and 12 so as to prepare them for job market and for higher studies.

The curriculum of Business Mathematics for Grade 11 and 12 is designed to equip the students with mathematical and statistical concepts applicable in business and economics. The purpose of this course, then, is to present mathematical and statistical skills and concepts so that the students will be able to use them in management, economics, and social sciences. As mathematics and statistics are widely used in economics, business and finance, the students need a certain level of skill and understanding of the basic mathematical and statistical methods. The pedagogical approaches in delivering the course should consider the balance between theory and practice. In doing so, students should provide ample opportunities of working actively in real-world problems. The same applies in case of student evaluation procedure too.

The curriculum has different sections: level-wise competencies, grade-wise learning outcomes, contents and their elaboration, suggested project works, learning facilitation process and the assessment procedure. The major content areas included in this course are: algebra, calculus, financial mathematics, linear programming, statistics and probability.

2. Level-wise Competencies

By the end of the grade 12, the students will have the following competencies.

1. Understand the concepts of algebra and employ a variety of thinking processes and strategies to truly understand the concepts that underlie the business problems.
2. Apply calculus in business and economics fields.
3. Apply partnership, present worth and discount, arithmetic sequence and series, geometric sequence and series, compound interest and depreciation, NPV and IRR, annuity in business and many other field.
4. Maximize the profit and minimize the cost under very limited resources used.
5. Apply statistical knowledge and skills for their personal development and future career pathways, and analyze the data using Ms. Excel.
6. Develop appropriate process skills for the acquisition and application of mathematical concepts and skills.

7. Apply mathematical and statistical knowledge and skills for their personal development and future career pathways.
8. Apply modern technology to solve problems related to business and economic fields.

3. Grade-wise Learning Outcomes

S. N.	Content Area	Grade 11	Grade 12
1	Algebra	1.1 Define functions, inverse and composite functions. 1.2 Draw the graphs of linear functions. 1.3 Find the slope and intercepts of a line. 1.4 Solve linear inequalities and use their properties. 1.5 Define absolute values and use their properties (without theoretical proof). 1.6 Apply the linear functions in economics and management. 1.7 Solve system of linear equations. 1.8 Solve economic problems involving systems of linear equations. 1.9 Solve quadratic equations, quadratic inequalities. 1.10 Sketch the graph of a quadratic function with its main characteristics. 1.11 Solve economic and management problems involving quadratic equations. 1.12 Define exponential and logarithmic functions. 1.13 Solve exponential and logarithmic equations. 1.14 Solve economic and management problems involving exponential and logarithmic functions. 1.15 Use excel for graphing linear	1.1 Perform matrix operations. 1.2 Use laws of matrix algebra. 1.3 Find the transpose of a matrix. 1.4 Evaluate determinants (up to third order). 1.5 Find adjoint and inverse of a matrix. 1.6 Solve system of linear equations by Cramer's rule, inverse matrix method and Gauss elimination method. 1.7 Solve problems of input/output analysis. 1.8 Use excel in solving problems of matrix algebra.

		and quadratic functions and for solving related equations.	
2	Calculus	2.1 Define the limit of a function. 2.2 Finding the limits of algebraic functions. 2.3 Define and test continuity of a functions. 2.4 Define the derivative of a function. 2.5 Find the derivatives by using rules of differentiations. 2.6 Differentiate implicit and parametric functions. 2.7 Find higher-order derivatives up to third order. 2.8 Use differentiation in marginal analysis. 2.9 Define integration as the reverse process of differentiation. 2.10 Integrate using rules/methods of integration (by decomposition of the integrand, by substitution and by parts). 2.11 Find the total cost, total revenue and total profit functions. (Note: Derivatives and anti-derivatives of algebraic, logarithmic and exponential functions only.)	2.1 Define monotonic functions and test the monotonicity. 2.2 Identify stationary point and point of inflection. 2.3 Solve problems related elasticity of demand. 2.4 Acquaint with relation between the marginal revenue, average revenue and elasticity of demand. 2.5 Optimize functions of one variable using derivatives. 2.6 Define the definite integral using the Fundamental Theorem of Calculus. 2.7 Find the area under a curve (simple problems only). 2.8 Solve problems of marginal analysis, consumer and producer surplus. 2.9 Solve first-order linear differential equations with constant coefficient and constant term. 2.10 Solve differential equations for limited and unlimited growth. 2.11 Dynamics of market price function(Dynamic analysis0)
3	Financial Mathematics	3.1 Solve problems of partnership, present worth and discount. 3.2 Define arithmetic sequences and series. 3.3 Solve the problem related to A.P 3.4 Solve economics and business problems involving arithmetic sequences and series.	3.1 Solve problems of geometric sequence and series. 3.2 Solve problems of compound interest and depreciation. 3.3 Find net present value and internal rate of return. 3.4 Compare investment projects. 3.5 Solve problems of ordinary annuity, annuity due, deferred

		3.5 Use excel in solving problems of financial mathematics.	annuity, perpetuities and sinking funds. 3.6 Use excel in solving problems of financial mathematics.
4	Linear Programming Problem	4.1 Find graphical solutions of a system of linear inequalities. 4.2 Solve LP problems by graphical method and apply them in economics. 4.3 Use excel in graphing linear inequalities and solving LPP by graphical method.	4.1 Define standard LP Problems. 4.2 Solve LP Problems by simplex method and its application in business and economics. 4.3 Solve standard minimization LP Problems using duality.
5	Statistics	5.1 Divide the dataset into classes. 5.2 Build cumulative frequency distribution. 5.3 Find arithmetic and weighted arithmetic means, correct mean, median, partition values (quartiles, deciles and percentiles) and mode. 5.4 Find the missing frequencies when total frequency and either mean, median or mode are given. 5.5 Do appropriate choice of an average. 5.6 Find range, quartile deviation, mean deviation, standard deviation and their relative measures. 5.7 Find variance, coefficient of variation and combined standard deviation. 5.8 Find the correct standard deviation. 5.9 Use excel in solving problems of central tendency and dispersions.	5.1 Find Karl Pearson's and Bowley's coefficient of skewness. 5.2 Find the five number summary of raw data. 5.3 Define correlation and find correlation coefficient by Karl Pearson's method and interpret the result. 5.4 Define regression and find regression lines of Y on X and X on Y using least square method. 5.5 Use excel in solving problems of Skewness, Correlation and Regression.

6	Probability	6.1 State the basic principles of counting and solve related problems. 6.2 Find permutations of set of objects all different and set of objects not all different (simple cases only) and solve the problems related to combinations (simple cases only). 6.3 State mathematical and empirical definition of probability. 6.4 Solve the simple problems of probability using combinations. 6.5 Acquaint with dependent and independent events. 6.6 State two basic laws of probability and use it to solve related simple problems. 6.7 Use excel in solving problems of permutation, combination and probability.	6.1 Define conditional probability and solve the related problems. 6.2 Use multiplication law of probability for dependent events. 6.3 State and apply the Bayes' theorem (simple problems only). 6.4 Define mathematical expectation and variance of a discrete random variable and solve related problems. 6.5 Define binomial distribution. 6.6 Use characteristics of the binomial distribution to solve the simple problems only. 6.7 Find mean and standard deviation of the binomial distribution. 6.8 Use excel in solving problems of conditional probability, Bayes' theorem, Expected Value, Binomial Probability.
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4. Scope and Sequence of Contents

S. N.	Content Area	Grade 11		Grade 12	
		Elaboration of Contents	Working hrs	Elaboration of Contents	Working hrs
1	Algebra	1.1 Linear Functions, Equation and Inequalities ○ Functions ○ Inverse and composite functions ○ Linear Equations ○ Linear Functions and their graphs ○ Slope and intercepts of a line	21	1.1 Matrices and Determinants ○ Matrix and its Operations ○ Laws of Matrix Algebra ○ Transpose of a matrix ○ Determinants (up to third order) ○ Adjoint and	21

		○ Inequalities and their properties (without theoretical proof) ○ Absolute values and their properties (without theoretical proof) 1.2 Applications ○ Demand, supply, cost, revenue and Profit functions ○ Elasticity of demand, supply and income ○ Budget and cost constraints 1.3 System of linear equations ○ Solving System of linear equations (Up to three variables) 1.4 Applications ○ Supply and Demand Analysis ○ Break-Even Analysis ○ Consumer and producer surplus ○ National income determination 1.5 Quadratic Functions and Equations ○ Quadratic Functions ○ Quadratic equations ○ Quadratic inequalities ○ Main characteristics (open upward and downward, domain and range, zeroes, vertex, axis of symmetry and intercepts)		Inverse of a matrix ○ Elementary row operations ○ Solving System of linear equations (Up to three variables by using Cramer's rule, inverse matrix method and Gauss elimination method) ○ Input/output analysis 1.2 Comp. Work: Excel for matrix algebra	
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		○ Sketching the graph of a quadratic function with its main characteristics 1.6 Applications ○ Supply and Demand Analysis ○ Break-Even Analysis ○ Optimization 1.7 Exponential and Logarithmic functions ○ Exponential functions ○ Logarithmic functions and their properties ○ Natural and common logarithms ○ Exponential and Logarithmic equations ○ Economics and Management Applications 1.8 Comp. Work: Excel for linear and quadratic functions and equations			
2	Calculus	2.1 Limit and Continuity ○ Limit of a function ○ Procedure of finding Limit ○ Limit at infinity ○ Continuity of a function Note: Algebraic function only 2.2 Differentiation ○ Derivatives ○ Average and Instantaneous Rates of	40	2.1 Applications of Derivatives ○ Monotonic functions ○ Stationary point and Point of inflection ○ Elasticity of demand and the derivatives ○ Relation between the marginal revenue, average revenue and elasticity of demand	40

		Change ○ Rules of differentiations ○ Implicit and parametric Differentiation ○ Higher-Order Derivatives upto third order Note: Algebraic, exponential and logarithmic function only 2.3 Applications ○ Marginal cost, Marginal revenue and Marginal profit 2.4 Indefinite Integration ○ Integration as the reverse process of differentiation ○ Rules of integrations ○ Total cost, total revenue and total profit function	○ Optimization of functions of one variable ○ Economic application of maximum and minimum points (Algebraic function only) 2.2 Definite Integral and its Applications ○ Definite Integral using the Fundamental Theorem of Calculus ○ Area Under a Curve (simple problems only) ○ Marginal analysis ○ Consumer and Producer Surplus 2.3 Differential equations and Applications ○ Differential equations and necessary terminologies ○ Solution of first-order linear differential equations with constant coefficient and constant term ○ Differential equations for limited and unlimited growth ○ Dynamics of market price functions (Dynamic	
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				analysis)	
3	Financial Mathematics	3.1 Financial Mathematics ○ Partnership ○ Present worth and Discount ○ Arithmetic Sequences and series and their applications 3.2 Comp. Work: Excel for financial mathematics	17	3.1 Financial Mathematics ○ Geometric sequence and series ○ Compound Interest and Deprecation ○ Net present value and internal rate of return ○ Ordinary annuity ○ Annuity due ○ Deferred annuity ○ Perpetuities ○ Sinking funds 3.2 Comp. Work: Excel for financial mathematics	17
4	Linear Programming Problem	4.1 Linear Programming Problem ○ Linear inequalities and their graphical solutions ○ Graphical method of solving LPP ○ Application of LPP in economics and business 4.2 Comp. Work: Excel for graphical method of solving LPP	10	4.1 Linear Programming Problem ○ Standard LP Problems ○ Simplex method of solving linear programming problem (two decision variables only) ○ Duality and Standard Minimization LP Problems 4.2 Comp. Work: Online Simplex Method	10

5	Statistics	5.1 Measures of central Tendency ○ Exclusive and inclusive classes, cumulative frequency distribution and open end classes ○ Mean (arithmetic and weighted arithmetic means) ○ Combined mean of two series ○ Median ○ Partition values ○ Mode ○ Choice of an average 5.2 Measures of Dispersion ○ Range and its relative measure ○ Quartile deviation and its relative measure ○ Mean deviation from mean and median and their relative measures ○ Standard deviation and its relative measure ○ Coefficient of Variation ○ Variance ○ Combined standard deviation 5.3 Comp. Work: Excel for central tendency and dispersion	20	5.1 Skewness ○ Karl Pearson's and Bowley's coefficient of skewness 5.2 Correlation ○ Correlation Coefficient by Karl Pearson's method and its Interpretations 5.3 Regression ○ Regression lines of Y on X and X on Y by least square method 5.4 Comp. Work: Excel for Skewness, five number summary of raw data, Correlation and Regression	20
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6	Probability	6.1 Permutation and Combination - Basic Principles of counting - Permutation: Set of objects all different, set of objects not all different (simple cases only) - Combination of things all different (simple cases only) 6.2 Probability - Mathematical and empirical definition of probability - Dependent and Independent Events - Basic laws of probability (without theoretical proof) 6.3 Comp. Work: Excel for Permutation, combination, probability and basic laws of probability.	12	6.1 Probability - Conditional probability - Multiplication Law of probability (dependent events only) - Bayes' theorem 6.2 Random Variables - Mathematical expectation and Variance of Discrete Random Variable 6.3 Binomial Distribution - Binomial distribution - Characteristics of the Binomial Distribution - Mean and Standard Deviation of the Binomial Distribution 6.4 Comp. Work: Excel for Conditional probability, Bayes' theorem, Expected Value, Binomial Probability	12
Total			120		120

5. Suggested Practical/Project Activities

During project works, students learn by actively engaging in real-world. Project work allows the students to study, do research and act by themselves using their abilities, interests, personal experience and aptitudes. Doing the computer works using excel requires students solve and analyze mathematical and statistical problems.

Each Student should do one project work or computer work (in the given table below, the second row in each content areas contains the project works and content areas where there is only one row the task is designed for project work) from each of six content areas and should give a 15-minute presentation. The project works or computer works will be documented in a file and will be submitted at the time of practical evaluation. Out of the project works, anyone can be presented at the time of practical evaluation.

Whatever the style, the project work should include the following points:

- Historical background
- Description
- Key features or properties
- Relationship with others
- Geometrical illustrations
- Practical significance
- Varieties of examples other than those given in the textbook
- Limitations
- Varieties of problems with solutions other than those given in the textbook
- Use in everyday life, business, economics, finance, etc.
- Conclusion

The project works will be evaluated on the basis of clarity of aims, originality, presentation style and the skills demonstrated.

S. N.	Content Area	Tasks	Working Hours
Grade 11			
1	Algebra	○ Calculating numerical expressions and creating function tables. ○ Graph linear functions and equations and finding intersection points using excel. ○ Solving equations using the quadratic formula, SOLVER, and graphs. ○ Evaluating expressions involving exponential and logarithms using excel. ○ Sketching graph of exponential and logarithmic functions using excel.	7
		○ Functions in the real world. ○ Linear functions and linear equations in the real world. ○ Linear functions and inequalities in events of daily lives.	

		○ Quadratic functions in the real world. ○ Application of quadratic equation and inequality in real life situation. ○ Sketching and drawing graphs of linear and quadratic functions.	
2	Calculus	○ Calculus in daily life. ○ Continuity of a function applied in everyday life. ○ Applications of derivatives in Business and Economics. ○ Applications of Calculus in day to day life. ○ Integration in the real world. ○ Application of integration in business and economics.	7
3	Financial Mathematics	○ Solving problems on present worth and discount. ○ Solving problems on arithmetic sequence and series using excel	6
		○ Partnership of sharing profit in the real world. ○ Applications of present worth and discount in daily life events. ○ Applications of arithmetic sequence and series in daily life events.	
4	Linear Programming Problem	○ Solving LP problems using Solver. ○ Applications of Linear programming problem in Economics and Business.	5
5	Statistics	○ Calculating mean, median, partition values and mode for individual series, discrete series and continuous series using excel. ○ Calculating combined mean of two series using excel. ○ Calculating maximum value, minimum value, range, quartile deviation, mean deviation, standard deviation and variance for individual series, discrete series and continuous series using excel. ○ Calculating coefficient of range, coefficient of quartile deviation, coefficient of mean deviation and coefficient of variation for individual series, discrete series and continuous series using excel.	11

		○ Investigation on how people use mean, median and mode in their daily life events. ○ Choice of averages ○ Measures of dispersion applied to events in real life situations.	
6	Probability	○ Solving some problems on permutation and combination using excel. ○ Finding probability of an event and probability of an event involving combination using excel. ○ Finding the probability related to two basic laws of probability using excel ○ Investigation on how probability is used in real life.	4
	Total		40
Grade 12			
1	Algebra	○ Performing basic operations on matrices using excel. ○ Evaluating a determinant of a Matrix using excel. ○ Solving system of linear equations using matrices. ○ Solving problems involving a Leontief input–output model using excel.	7
		○ Applications of matrices in real life. ○ Methods of solving system of linear equations by using Cramer’s rule, inverse matrix method and Gauss elimination method.	
2	Calculus	○ Applications of maxima and minima of one variable in daily life. ○ Calculating consumer surplus and producer surplus using definite integral. ○ Applications of differential equations with constant coefficient and constant term in economics.	7
3	Financial Mathematics	○ Solving some problems of geometric sequence and series using excel. ○ Solving some problems of compound interest and depreciation using excel. ○ Solving some problems of net present value and internal rate of return using excel. ○ Solving some problems on amount of immediate annuity	6

		and annuity due using excel. ○ Solving some problems on present value of immediate annuity and annuity due using excel. ○ Solving some problems on present value of deferred annuity using excel. ○ Solving some problems on present value of perpetual annuity using excel.	
		○ Investigation on geometric sequence and series can be applied in real life situations. ○ Applying the concept of compound interest and depreciation in all areas of life. ○ Net present value (NPV) and internal rate of return (IRR) methods for project evaluation. ○ Calculating amount and present values of annuities in real life situations.	
4	Linear Programming	○ Simplex method of solving linear programming problem(LPP) ○ Simplex method of solving linear programming problem(LPP)	5
5	Statistics	○ Calculating Karl Pearson's and Bowley's coefficient of skewness for individual series, discrete series and continuous series using excel. ○ Calculating five number summary for individual series, discrete series and continuous series using excel. ○ Calculating Karl Pearson's correlation coefficient using excel. ○ Estimating regression lines of Y on X and that of X on Y using excel. ○ Skewness in statistics. ○ Calculating correlation coefficient by Karl Pearson's method and its interpretation in real life situations. ○ Estimating simple regression lines of Y on X and X on Y in real life situations.	11
6	Probability	○ Solving some problems on conditional probability and Bayes' theorem using excel. ○ Finding expected value and variance of discrete random variable using excel. ○ Finding the probability of an event of binomial distribution	4

		using excel. ○ Finding the mean and standard deviation of binomial distribution using excel.	
		○ Developing conceptual understanding of Conditional Probability and Bayes' theorem through explanation. ○ Developing conceptual understanding of Binomial distribution through explanation.	
		Total	40

Pre-requisites for computer based tasks: Spreadsheets Introduction, Files, Cells, Cell Address, Cell Format, Cell Content, Cell Value, Formulas, Copy, Paste, Fill, Charts, Conclusion.

6. Learning Facilitation Methods and Process

The following principles should guide the learning facilitation of business mathematics:

- One of the most important principles in teaching mathematics is **"Let It Make Sense"**. The course assumes minimal mathematical background but includes the usefulness and relevance of basic mathematics in economics, finance, and business.
- **Students need to be able to navigate their lives in this ever-so-complex modern world.** This involves dealing with interest, annuities, taxes, loans, purchases, budgeting etc. Our youngsters need to be able to handle money wisely. All that requires good understanding of parts, proportions, and percentages.
- Another very important approach of mathematics education as a whole is to **enable the students to understand information around us**. In today's world, this includes quite a bit of scientific information. Being able to read through it and make sense of it requires knowing statistics and probability.
- We need to **prepare our students for further studies**. Not everyone ultimately needs algebra, calculus, linear programming, but many do, and teens don't always know what profession they might choose or end up with.
- **Let students see some beauty of mathematics and learn to like it**, or at the very least, make sure they don't have negative feeling towards mathematics.
- Finally, **let students be familiar with modern computation skill**. This involves working with excel.

It's important to **learn how to use any tool** the student might acquire. Quantity won't equal quality. Knowing a few "math tools" inside out is more beneficial than a mindless dashing to find the newest activity to spice up the math lessons. In this course, we do not show how the mathematical results have been obtained and proved, but we show how they may be used in real-life economics and business.

Gaining purposeful learning experiences through solving problems in relevant and meaningful contexts allows students to view mathematics in a practical setting relevant to their intended careers, and also motivates them to move on to increasingly more abstract concepts.

Teacher has to analyze and diagnose the weakness of the students and create appropriate learning environment to solve mathematical problems in teaching learning process. The

following are some of the methods and techniques which can be used in delivering this course.

- Problem solving
- Case study
- Project work
- Question answer
- Discussion
- Discovery
- ICT
- Co-operative learning
- Lecture

7. Student Assessment

Continuous assessment of students for formative purpose will be an integral part of teaching learning process. Student's summative evaluation will be done using both internal (25%) and external examination (75%).

(a) Internal Evaluation

Practical evaluation includes written tests (first term, second term), classroom participation and project work including presentation /excels lab work. The scores of evaluation will be used for providing feedback and to improve their learning. The criteria for internal evaluation is shown in the following table:

S. N.	Criteria	Marks
1	Classroom participation (Daily attendance, home assignment and classwork, participation in learning, participation in other activities)	3
2	Trimester exam (3 marks from each trimester exam)	6
3	Project work, project report and presentation	16
	Total	25

(b) External Evaluation

External evaluation of the students will be based on the written examination. It carries 75 percent of the total weightage. The types and number questions will be as per the test specification chart developed by the Curriculum Development Centre.