DEPARTMENT OF MATHEMATICS

St. Joseph's college, Moolamattom

Course Outcomes

BSc Mathematics Model I

(2017 Admission onwards)

COURSE OUTCOMES FOR CORE COURSES

Semester I - Foundation of Mathematics

At the end of the course on Foundation of Mathematics, the students will be able to: -

1. **Acquire** the knowledge of mathematical logic,**apply** the rules of inference and **distinguish** between various proof methods
2. **Describe** sets, **apply** set operations, **define** functions and **describe** some of the elementary functions
3. **Explain** relations and **represent** them in various forms, **discriminate** equivalence relations from partial order relations
4. **Determine** the roots of an equation and **establish** relationship between the roots and coefficients. **Explore** solutions of cubic and bi-quadratic equations and **formulate** some general rules for locating roots

Semester II - Analytic Geometry, Trigonometry and Differential Calculus

At the end of the course on Analytic Geometry, Trigonometry and Differential Calculus, the students will be able to: -

1. **Develop** fundamental ideas of conic sections and **formulate** their properties, also **construct** their parametric and polar forms
2. Differentiate between circular and hyperbolic functions, **establish** relationship between them and **separate** certain functions into real and imaginary parts
3. **Evaluate** the sum of various standard trigonometric series and **rewrite** some specific polynomials into their factors
4. **Estimate** the n^{th}derivatives of functions and **evaluate** certain types of indeterminate forms

Semester III – Calculus

At the end of the course on Calculus, the students will be able to: -

1. **Express** functions as infinite series using Taylors and Maclaurin's theorem, **apply** derivatives to **determine** the arc length, curvature, evolutes and involutes, and asymptotes and envelopes of given curves
2. **Compute** the partial derivatives of functions of several variables using chain rule, **identify** saddle points and **estimate** the extrema of functions using Lagrange multipliers.

3. **Apply** integration to **evaluate** the arc length of curves, surface area and volume of revolution of curves about the coordinate axes and other given lines
4. **Evaluate** double and triple integrals to **determine** the area and volume of given surfaces. Also **formulate** substitutions to **rewrite** and **evaluate** multiple integrals

Semester IV – Vector Calculus, Theory of Numbers and Laplace Transform

At the end of the course on Vector Calculus, Theory of Numbers and Laplace Transform, the students will be able to: -

1. **Determine** the vector and parametric equations of straight lines, planes and curves and also their arc length and curvature. C**onstruct** unit tangent lines and planes, and normal lines and planes. **Deduce** the directions in which a given function is increasing decreasing or in which direction it has zero change.
2. **Apply** vector integration to **calculate** the work, circulation and flux, determine whether a field is conservative and determine its scalar potential. Also **validate** Green's theorem, Gauss' Divergence theorem and Stoke's theorem for given vector fields and curves
3. **Analyze** the basic properties of congruence of numbers. **State** Fermat's theorem, Wilson's theorem and Euler's Phi function and **apply** them to solve a variety of number theoretic problems
4. **Acquire** the knowledge of Laplace and Inverse Laplacetransforms and **employ** in solving differential and integral equations

Semester V – Mathematical Analysis

At the end of the course on Mathematical Analysis, the students will be able to: -

1. **Explain** finite and infinite sets and **recall** various properties of real numbers $\mathbb{R}$ and **apply** them appropriately
2. **Explain**the concept of sequences and **evaluate** limits of sequences. Also **derive** various associated theorems
3. **Illustrate** the idea of series, their absolute convergence and **employ** associated tests of convergence and non-absolute convergence to given series
4. **Define** limits of functions, **construct** theorems associated and **create** their extensions

Semester V – Differential Equations

At the end of the course on Differential Equations, the students will be able to: -

1. **Acquire** the knowledge of various types first order ordinary differential equations, **classify** them and **develop** methods for solving them
2. **Apply** the knowledge of geometry and differential calculus to **determine** the orthogonal trajectories of a given family of curves and **interpret** the result
3. **Solve** various types of second and higher order differential equations using specified methods and **apply** given boundary conditions to **determine** particular solutions

4. **Analyze** a given differential equation, **locate** and **classify** its singular points and **determine** its solution through power series method
5. **Formulate** equations of various families of surfaces and **construct** the partial differential equations satisfied by them, eliminating arbitrary constants or functions involved
6. **Solve** first order linear partial differential equations in three variables by Lagrange's method and **determine** the integral surfaces passing through or containing given curves

Semester V – Abstract Algebra

At the end of the course on Abstract Algebra, the students will be able to: -

1. **Articulate** various types of group properties, subgroups and cyclic groups and **establish** elementary properties of groups and cyclic groups,**create** group tables for finite groups
2. **Define** permutations, cosets, orbits and cycles, **compose** new permutations from existing ones and **construct** theorems including Cayley's and Lagrange's
3. **Explain** group homomorphism, factor groups, normal groups and **discover** their applications
4. **Differentiate** between rings, integral domains,fields, ideals and factor rings, **illustrate** their simple applications

Semester V – Human Rights and Mathematics for Environmental Studies

At the end of the course on Human Rights and Mathematics for Environmental Studies, the students will be able to: -

1. **Recognize** the need, scope and importance of environmental studies and public awareness. **Differentiate** between various renewable and non-renewable resources and the need for their preservation
2. **Debate** on the bio diversity of India and its conservation, various causes of environmental pollution and its prevention. **Critically analyze** the existing social and environmental issues in the context of various Government Acts
3. **Formulate** the relationship between Fibonacci Numbers and Golden Ratio in Mathematics and **speculate** theories of their intervention in many naturally occurring phenomena
4. **Interpret** the constitutional provisions of Human Rights, **judge** how the constitutions of UN and India ensure the protection and maintenance of human rights and **intervene** in related awareness programmes. **Examine** various reports and case studies in India on environmental issues and **persuade** the public to act accordingly.

Semester V – Open Course: Applicable Mathematics

At the end of the course on Applicable Mathematics, the students of other streams will be able to: -

1. **Acquire** the knowledge of essential mathematical methods and techniques required for their higher studies, apply short cut methods of solving problems that they encounter in studies and competitive examinations
2. **Summarize** the basic properties of numbers, LCM, HCF of both integers and fractions and **solve** problems related to ratio and proportion, profit and loss

3. **Solve** quadratic equations, **apply** the theory of permutations and combinations in relevant situations and **estimate** heights and distances using trigonometric fundamentals
4. **Compute** simple and compound interests and **develop** skill in dealing with problems related to time and work, work and wages, time and distances. **Express** certain functions as series using of exponential or logarithmic series
5. **Apply** mensuration formulae appropriately, **factorize** quadratic and cubic polynomials and **illustrate** basic rules of differentiation with suitable examples

Semester VI – Real Analysis

At the end of the course on Real Analysis, the students will be able to: -

1. **Develop** the fundamental concepts of continuity and uniform continuity of functions, **discover** monotonicity and **determine** inverse of functions
2. **Recall** the process of finding the derivatives of functions, **establish** mean value theorem and its applications. **Employ** L Hospital Rule and **apply** Taylor's Theorem in relevant situations
3. **Observe** the fundamental concepts of Riemann integral, Riemann integrable functions and discuss the fundamental theorem
4. **Distinguish** between pointwise and uniform convergence, **manipulate** interchange of limits and **discuss** series of functions

Semester VI – Graph Theory and Metric Space

At the end of the course on Graph Theory and Metric Space, the students will be able to: -

1. **Acquire** the basic definition of a graph and related terminologies,**translate** graphs into matrices and vice versa
2. **Describe** trees and tours, and **illustrate** classical examples in graph theory
3. **Explain** metric spaces and various types of sets in metric spaces. **Distinguish** between open set, closed set and Cantor set
4. **Interpret** the convergence of functions in metric spaces, completeness of metric spaces and **judge** the behavior of continuous mappings in metric spaces

Semester VI – Complex Analysis

At the end of the course on Complex Analysis, the students will be able to: -

1. **Describe** analytic functions and their properties including Cauchy Riemann equations. **Restate** elementary functions such as exponential, logarithmic, trigonometric and hyperbolic functions and their inverses for a given complex variable
2. **Compute** antiderivatives of complex functions. **Illustrate** contours, connected, disconnected and multiply connected domains. **Establish** and **apply** Cauchy Goursat theorem, Cauchy's integral formula, Liouville's theorem, fundamental theorem of algebra and Maximum Modulus Principle

3. **Modify** the idea convergence of sequences and series of real numbers to complex numbers. **Derive** and **apply** Taylor's and **employ** Laurent's series to find the expansions of non-analytic functions in given domains
4. **Identify** various types of singularities. **Evaluate** residues and **apply** Cauchy's residue theorem to evaluate of improper integrals

Semester VI – Linear Algebra

At the end of the course on Linear Algebra, the students will be able to: -

1. **Review** on algebra of matrices, **appraise** various row (column) operations on matrices, **determine** rank and column rank, **apply** elementary transformations in solving linear equations
2. **Construct** the inverse of a given matrix, **describe** vector spaces and **construct** basis for them
3. **Explain** linear transformations, **compute** kernel, range, rank and nullity, **construct** transformation matrices and index of nilpotency
4. **Determine** eigen values, eigen vectors and eigen spaces, **apply** the process of diagonalization.

Semester VI – Operations Research

At the end of the course on Operations Research, the students will be able to: -

1. **Explain** mathematical modeling of a LPP, **analyze** a given problem and formulate it as an LPP, **describe** various methods of solution, **construct** a solution and **interpret** the result
2. **Formulate** the of Dual of a LPP and **establish** related theorems
3. **Design** and **develop** mathematical models of transportation and assignment problems and **determine** their optimal solutions
4. **Explain** theory of games,strategies, games with and without saddle points, **construct** solutions through various methods

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Mathematics for BSc (Physics & Chemistry Cores) and Integrated MSc Computer Science – Data Science

Semester I –Partial Differential Equations, Matrices, Trigonometry and Numerical Methods

At the end of the course on Partial differential equations, Matrices, Trigonometry and Numerical Methods, the students will be able to: -

1. **Differentiate** between functions of a single and multiple variables, **compute** partial derivatives and **apply** chain rule in different contexts
2. **Determine** the rank of a matrix through elementary transformations, **solve** linear equations using matrices, **construct** the characteristic equation of a matrix, **verify** Cayley's theorem and **use** it to determine the inverse and powers of that matrix

3. **Express** powers of angles of sin, cos and tan in corresponding ratios of multiples of the angle and vice versa, **discuss** the relationship between circular and hyperbolic functions and **employ** them to split a complex function into its real and imaginary parts, **evaluate** the sum of various standard trigonometric series
4. **Locate** and **determine**the roots of quadratic and cubic equations using bisection method, method of false position, iteration method and Newton-Raphson method

Semester II – Integral Calculus and Differential Equations

At the end of the course on Integral Calculus and Differential Equations, the students will be able to: -

1. **Determine** volumes of surfaces of revolution using cross sections, cylindrical shells, **calculate** arc lengths and areas of surfaces of revolution
2. **Evaluate** double and triple integrals to **determine** the area and volume of given surfaces.
3. **Solve** ordinary differential equations by the method of separation of variables, exact equations, equations reducible to exact form, linear equations, solutions by substitutions, homogeneous equations and Bernoulli's method
4. **Formulate** equations of various families of surfaces and **construct** the partial differential equations satisfied by them, eliminating arbitrary constants or functions involved, **solve** first order linear partial differential equations in three variables by Lagrange's method

Semester III – Vector Calculus, Analytic Geometry and Abstract Algebra

At the end of the course on Vector Calculus, Analytic Geometry and Abstract Algebra, the students will be able to: -

1. **Determine** the vector and parametric equations of straight lines, planes and curves and also their arc length and curvature, c**onstruct** unit tangent lines and normal lines, **establish** the directions in which a given function is increasing decreasing or in which direction it has zero change.
2. **Apply** vector integration to **calculate** the work, circulation and flux,determine whether a field is conservative and determine its scalar potential, **validate** Green's theorem, Gauss' Divergence theorem and Stoke's theorem for given vector fields and curves
3. **Convert** Cartesian coordinates into polar and vice versa, **derive** the equations of conic sections in Cartesian and polar coordinates and **construct** graphically
4. **Develop** the idea and properties of groups, subgroups and cyclic groups, **construct** permutation groups, discuss group homomorphism and its properties

Semester IV – Fourier Series, Laplace Transform and Complex Analysis

At the end of the course on Fourier Series, Laplace Transform and Complex Analysis, the students will be able to: -

1. **Describe** periodic functions and trigonometric series**, define** and **compute** Fourier series of periodic functions in various intervals

2. **Define** Laplace transform and inverse Laplace transforms of standard functions and **determine** the Laplace transforms and inverse Laplace transforms of other related functions, **employ** inverse Laplace transforms to solve differential equations and **apply** Convolution theorem to solve integral equations
3. **Describe** analytic functions and their properties including Cauchy Riemann equations, **restate** elementary functions such as exponential, logarithmic, trigonometric and hyperbolic functions and their inverses for a given complex variable
4. **Compute** antiderivatives of complex functions, **illustrate** contours, connected, disconnected and multiply connected domains, e**stablish** and **apply** Cauchy Goursat theorem, Cauchy's integral formula.

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Complementary Statistics for BSc Mathematics (Main)

Semester I – Descriptive Statistics

At the end of the course on Descriptive Statistics, the students will be able to: -

1. **Explain** statistics as data, **differentiate** between population and sample, qualitative and quantitative data, continuous and discrete data, **illustrate** types of scale, **explain** various methods of collection of data and sampling
2. **Define** and **compute** various measures of averages and dispersion, weighted averages, relative measures of dispersion, **create** ogives and box plot, ,**test** for the uniformity and consistency of data using dispersion
3. **Explain** and **compute** raw moments and central moments and their interrelation ship, **evaluate** coefficients of skewness and kurtosis using appropriate formulae and **judge** the nature of data
4. **Define** and **compute** index numbers, price relatives, simple and weighted index numbers, price and quantity index numbers, various types of index numbers, **test** the appropriateness of formulae for index numbers using time and factor reversal tests, **construct** consumer price index through different methods

Semester II – Probability Theory

At the end of the course on Probability Theory, the students will be able to: -

1. **Define** random experiments, events and their operations, types of events, compute probability and **illustrate** various approaches to probability, **apply** addition and multiplication theorems of probability and Bayes' theorem
2. **Distinguish** between continuous and discrete random variables, probability mass and density functions, conditional and unconditional probabilities, **apply** change of variable, **employ** methods of Jacobian and **construct** cumulative distribution functions
3. **Explain** two components random vector, **define** and **construct** probability mass and density functions, marginal and conditional density functions and distributions, **examine** the independence of bivariate random distributions

4. **Construct** bivariate frequency distributions and **define** correlation, represent bivariate data through scatter diagrams, **calculate** Karl Pearson's and Spearman's correlation coefficients, **construct** regression equations and **distinguish** between regression equations of x on y and y on x, **fit** polynomial equations to given bivariate data

Semester III – Probability Distributions

At the end of the course on Probability Distributions, the students will be able to: -

1. **Define** expectation of random variables and **indicate** their functions, **calculate** raw moments, central moments and **establish** their interrelationship, **determine** measures of averages and dispersion using moments, **express** Pearson's correlation coefficient in terms of expectation, **determine** characteristic functions and moment generating functions
2. **Illustrate** Uniform, Bernoulli, Binomial, Poisson, Geometric, Hyper Geometric, Gamma, Exponential and Beta - **compute** their mean, variance, mgf and properties, **apply** normal distribution and all its properties
3. **Describe**, **reproduce** and **apply** Chebychev's inequality, weak law of large numbers, Bernoulli's and Chebychev's forms and central limit theorem.
4. **Articulate** the concept of sampling from probability distributions iid observations, **recall** the concept of sampling distributions, statistic and standard error, mean and variance of sample mean when sampling is from a finite population, sampling distribution of mean and variance from normal distribution, **discuss** Chi-Square, t, F and inter relationships among them and **apply** them in relevant situations

Semester IV - Statistical Inference

At the end of the course on Statistical Inference, the students will be able to: -

1. **Describe** the concepts of estimation, estimators and estimates, points and interval estimates, **explain** properties of good estimators and **apply** sufficiency factorization theorem
2. **Explain** various methods of moments, maximum likelihood, and invariance property of ML estimates, minimum variance, **illustrate** Cramer-Rao inequality, **solve** problems based on confidence intervals of mean, variance and proportions
3. **Explain** statistical hypothesis, null, alternate, simple and composite hypothesis, Type I and Type II errors, **compute** and **sketch** critical region, **determine** size and power of a test, p-value, Neyman-Pearson approach, **apply** large sample tests for means, difference of means, proportion and difference of proportion, **use** Chi square test for independence and homogeneity
4. **Apply** Normal tests for mean, difference of means and proportion, t-tests for mean and difference of means, paired t-test, test for proportion, chi square test, F-test for ratio of variances and **formulate** conclusions

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Complementary Mathematics for BBA

Semester I – Fundamentals of Business Mathematics

At the end of the course on Fundamentals of Business Mathematics, the students will be able to:

1. **Observe** modern theory of Mathematics, **recall** sets and types of sets, and operations on sets
2. **Recall** number systems, **apply** ratio and proportion, variation, sequences, arithmetic and geometric progressions, their n^{th} terms and sum to n terms, sum to infinity of a geometric progression to **solve** many routine type problems
3. **Differentiate** between permutations and combinations, **apply** them to solve problems, **define** logarithm and **use** them in computations and simplification of expressions, **compute** compound interest and depreciation
4. **Define** matrices and matrix operations, define and **evaluate** determinants and determine ranks of matrices, inverse of a matrix and **solve** linear system of equations using matrices

Semester II – Mathematics for Management

At the end of the course on Mathematics for Management, the students will be able to:-

1. **Represent** points in plane as coordinates in Cartesian coordinate system, **determine** the length of a line segment and area of a triangle, **apply** section formula and **examine** collinearity of three points
2. **Define** and **calculate** gradient of a line, **employ** different forms of equation of straight lines, **apply** conditions for parallelism and perpendicularity and concurrency of three points
3. **Define** arithmetic and geometric progressions, **apply** the formula to sum the n terms of arithmetic and geometric series
4. **Calculate** of interests and discounts, present value and annuity, present value of money and annuities

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Complementary Statistics for BBA

Semester I – Fundamentals of Business Statistics

At the end of the course on Fundamentals of Business Statistics, the students will be able to:-

1. **Describe** the origin, meaning, scope and limitations of Statistics, **discuss** its relationship with business and industry
2. **Explain** various methods of collection, classification and tabulation of data, **represent** data through pie diagrams and graphs
3. **Describe** various measures of central tendency and dispersion, **compare** their merits and demerits, **explain** correlation, **compute** Karl Pearson's coefficient of correlation and

spearman's coefficient of correlation, **determine** regression equations and **use** them in forecasting

4. **Describe** components of a time series, **compute** trend and seasonal variations through the average method

Semester II – Statistics for Management

At the end of the course on Statistics for Management, the students will be able to:-

1. **Explain** basic concepts in probability, **employ** addition and multiplication theorems in probability calculations, **calculate** conditional probability and **apply** of Baye's theorem for finding inverse probabilities
2. **Distinguish** between discrete and continuous random variables, **illustrate** Binomial, Poisson and Normal Distributions, **apply** them in related problems, **calculate** their means and variance and **explore** their properties
3. **Discuss** various methods of sampling, **differentiate** statistics from parameters, **explain** various sampling distributions, **compute** standard error and **apply** central limit theorem
4. **Explain** hypothesis and procedure for testing hypothesis, **apply** and **validate** tests of significance for attributes and means
5. **Devise** Chi square test and goodness of fit, **design** chi square test for independence, **discover** its uses and limitations

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Complementary Mathematics for BBM

Semester I - Business Mathematics I

At the end of the course on Business Mathematics I, the students will be able to:-

1. **Discuss** ratio, proportion and variation, laws of indices, **formulate** and **solve** linear and quadratic equations
2. **Explain** sets and type of sets, operate on sets, **define** relations and functions and **combine** functions
3. **Discuss** and **compute** profit and loss, discounts, **explain** logarithms and its laws, **determine** simple and compound interests
4. **Define** AP, and GP, **calculate** their n^{th} terms, sum to n terms, **determine** the sum, sum of squares, sum of cubes of first n natural numbers and their simple applications, sum to infinity of a GP, **discuss** HP and **establish** the relationship among AP, GP and HP
5. **Distinguish** between permutations and combinations, and **apply** them to **solve** related problems

Semester II Business Mathematics – II

At the end of the course on Business MathematicsII, the students will be able to:-

1. **Discuss** matrices and types of matrices, **define** basic matrix operations, **describe** properties of matrices and **verify** them, **construct** associated matrices, **evaluate** determinants, **distinguis**h between singular and non-singular matrices, minors and cofactors of elements, **construct** the inverse of a matrix, **apply** Cramer's Rule to **solve** linear system of equations, **determine** rank of a matrix by evaluating sub matrices
2. **Define** vector and its types, dot product of vectors, **derive** conditions for vectors to be parallel and perpendicular
3. **Explain** dependent and independent variables, **evaluate** limits of rational functions using formula, **find** derivatives, **apply** addition, multiplication and quotient rules of differentiation, **determine** the maxima and minima of algebraic functions
4. **Perform** integration of simple algebraic, exponential and logarithmic functions, **apply** integration by parts, **employ** differentiation and integration to **estimate** marginal revenue cost and average cost
5. **Define** the Cartesian coordinate system, **derive** and **apply** distance formula, **construct** equations of straight lines in slope intercept form, point slope form, two point and intercept form

COURSE OUTCOMES FOR COMPLEMENTARY COURSES

Complementary Statistics for BBM

Semester I – Business Statistics I

At the end of the course on Business Statistics I, the students will be able to:-

1. **Describe** meaning, scope and limitations of Statistics, **analyze** various methods of collection and editing of data, **employ** sampling techniques, **represent** data diagrammatically and graphically representation of data
2. **Discuss** meaning and characteristics of a good average and a good measure of dispersion, **compute** of measures of central tendency and measures of dispersion, **compare** their merits and demerits
3. **Explain** meaning, definition and types of correlation, **compute** of coefficient of correlation using Karl Pearson's and Spearman's methods and **interpret** the result
4. **Explain** meaning of regression and **compute** and **identify** regression coefficients and equations

Semester II- Business Statistics – II

At the end of the course on Business Statistics II, the students will be able to:-

1. **Define** and **discuss** the importance of index numbers, **compute** index numbers by simple aggregative method, simple average of price relatives method, **construct** Laspeyer's, Paasche's, Fisher's, Bowley-Dorbish, Marshall-Edgeworth indices, quantity index numbers, **employ** Time, Factor Reversal and circular tests for finding an ideal index number, validate the tests and **discuss** and **compute** of cost of living index number.
2. **Describe** time series, its meaning and computation, **determine** trend by freehand method, semi average method and method of moving averages, **construct** straight line trend by the method of least squares and **apply** it for prediction
3. **Define** and **compute** probability, **apply** addition, multiplication theorems and conditional probability to **assess** probabilities
4. **Discuss** meaning, assumptions and limitations of interpolation and extrapolation, **discover** and **predict** appropriate methods of projecting required data using Newton's forward interpolation method, Newton's method of divided differences and Lagrange's method
5. **Formulate** and **solve** inequalities in two variables by the method of linear programming, **minimize** cost in transportation problems by lowest cost entry method, **schedule** an assignment so that the cost in the Assignment problem minimal by Hungarian method