

**PROGRAM OUTCOMES  
AND  
COURSE OUTCOMES**

**OF**

**DEPARTMENT OF MATHEMATICS  
KALNA COLLEGE**

**FOR**

**NAAC ASSESSMENT**

# PROGRAM OUTCOMES

## **MATHEMATICS PROGRAM MISSION :**

The mission of the **Bachelor Degree Program in Mathematics** is to equip students with analytic and problem solving skills for their future careers and post-graduate works .Mathematics is a subject which is a brainchild of Human Beings and possibly must be treated as a most sophisticated subject amongst all science subjects. So our program for mathematics has been builded up so beautifully that a newcomer student can acquire a large amount of information regarding Mathematics . Classes develop student abilities and aptitudes to implement mathematical concepts, methods and ideas not only to solve problems in this subject only but also to tackle problems in various fields such as Physics,computer Science ,Statistics and many other branches of modern science .Students learn to communicate ideas effectively and to digest new information and concepts independently .Students are encouraged to develop intellectually competent so that they can involve in different education sectors and professional organisations .The department co-operates fully with the UGC , The university of Burdwan and college authorities in every part of their academic planning and incorporate each and every academic decisions which are eventually helps to build up our knowledge based education system in a more concrete way .

The Mathematics program of our college in compliance with the syllabus structured by our Burdwan University promotes mathematical skills and knowledge for their intrinsic beauty, effectiveness in developing proficiency in analytical reasoning, and utility in modeling and solving real world problems. To responsibly live within and participate in the transformation of a rapidly changing, complex, and interdependent society, students must develop and unceasingly exercise their analytical abilities.

Students who have learned to logically question assertions, recognize patterns, and distinguish the essential and irrelevant aspects of problems can think deeply and precisely, nurture the products of their imagination to fruition in reality, and share their ideas and insights while seeking and benefiting from the knowledge and insights of others. Students majoring in Mathematics attain proficiency in critical thinking . The ability to identify, reflect upon, evaluate, integrate, and apply different types of information and knowledge to form independent judgments. Analytical and logical thinking and the habit of drawing conclusions based on quantitative information.

## **MATHEMATICS PROGRAM GOALS :**

Mathematics department of Kalna College aims to produce academically sound students who will

- successfully compete and take part in various national and international level examinations .
- be well grounded in the basic theoretical excursions in algebra, geometry and beginning level calculus etc.
- develop an understanding of the underlying unifying structures of mathematics i.e. sets,relations,mappings,algebraic structures and the beautiful relationships amongst them .
- develop and understand the importance of proof which distinguishes mathematics from all other disciplines and will demonstrate proficiency in understanding mathematical philosophy and proofs .

- be capable of exchanging mathematical ideas, concepts and overviews both orally and in writing .
- be able to assess and interpret complex situations, choose among several potentially appropriate mathematical methods of solution, persist in the face of difficulty, and present full and cogent solutions that include appropriate justification for their reasoning.
- understand the basic rules of logic, including the role of axioms or assumptions .
- gain exposure to a variety of areas of mathematics and related fields such as computer science, the natural sciences, business and economics.
- gain experience investigating the real world problems and learn to how to apply mathematical ideas and models to those problems.
- develop the ability to read and learn mathematics on their own. Such maturity is a much a function of how mathematics is learned as it is of what mathematics is learned.
- understand the historical and contemporary role of mathematics and be able to place the discipline properly in the context of other human intellectual achievement.
- be master enough to know how and when to use concepts, ideas and important results .
- become involved with professional organizations and will network with successful former graduates of our programs. Such as exposure will aid them in establishing professional contacts, in gaining insight about future employment prospects, and in tailoring their education to complement their career goals .

- be able to distinguish a coherent argument from a fallacious one, both in mathematical reasoning and in everyday life .
- understand and be able to articulate the differences between inductive and deductive reasoning .
- formulate conjectures by abstracting general principles from examples.

### **Problem solving ability :**

Students will be able to

- formulate and solve abstract mathematical problems .
- recognize real-world problems that are amenable to mathematical analysis, and formulate mathematical models of such problems .
- apply mathematical methodologies to open-ended real-world problems .
- recognize connections between different branches of mathematics .
- recognize and appreciate the connections between theory and applications.

### **Effective communication :**

Students will be able to

- present mathematics clearly and precisely to an audience of peers and faculty .
- appreciate the role of mathematical proof as a means of conveying mathematical knowledge .

- understand the differences between proofs and other less formal arguments .
- make vague ideas precise by formulating them in mathematical language
- describe mathematical ideas from multiple perspectives .
- explain fundamental mathematical concepts or analyses of real-world problems to non-mathematicians.

### **Critical thinking :**

Students will

- understand the basic rules of logic, including the role of axioms or assumptions .
- appreciate the role of mathematical proof in formal deductive reasoning .
- be able to distinguish a coherent argument from a fallacious one, both in mathematical reasoning and in everyday life .
- understand and be able to articulate the differences between inductive and deductive reasoning .
- proficiently construct logical arguments and rigorous proofs .
- formulate conjectures by abstracting general principles from examples .

## SUBJECT SPECIFIC OUTCOMES

Students must demonstrate mastery in the following basic areas of mathematics:

Number theory , Algebra , Analysis , Geometry , Metric Space on a basic level in lower division courses and at an advanced level in upper division courses. ”we must endeavor to persuade those who are prescribe to be the principal men of our State to go and learn arithmetic, not as amateurs, but they must carry on the study until they see the nature of numbers with the mind only; not like merchants or retail-traders, with a view to buying or selling, but for the sake of their military applications and the benefit of the soul. . . I must add how charming the science is, and in how many ways it conduces to our desired end, if pursued in the spirit of a philosopher, and not of a shopkeeper!”

–Plato, *The Republic*

### **Algebra :**

**Abstract algebra** involves the study of algebraic structures such as groups, rings, fields, modules, vector spaces, and Boolean algebras. **Linear algebra** is a crucial subfield of algebra, both as an introduction to abstract algebraic structures and as a body of advanced results of immense importance in diverse areas of application. Number theorists study properties of the integers, as well as those of mathematical objects constructed from or generalizing the integers. Combinatorics involves finite or countable discrete structures, such as abstract graphs.

**Course : BMH1CC02**

## **Calculus and Analysis :**

Analysis extends and refines calculus; it encompasses differentiation, integration, measure, limits, infinite series, and analytic functions, primarily in the context of real and complex number systems. In much of analysis, the emphasis is not on finding explicit solutions to specific problems, but rather on determining which problems can be solved and what general properties solutions may share. Ordinary and partial differential equations play a central role in analysis, and are widely used in modeling real-world systems.

**Course : BMH1CC01 , BMH2CC03, BMH2CC04**

## **Geometry and Metric Spaces :**

”My noble friend, geometry will draw the soul towards truth, and create the spirit of philosophy . . . nothing should be more sternly laid down than that the inhabitants of your fair city should by all means learn geometry. Moreover, the science has significant indirect effects...in all departments of knowledge, as experience proves, any one who has studied geometry enjoys infinitely quicker understanding than one who has not.”

**–Plato, The Republic**

Geometry explores the implementation and far-reaching consequences of systems of measurement; topology addresses questions pertaining to shape and global structure. Non- Euclidean geometry, differential geometry (the extension of calculus to mapping of curves, surfaces, and their generalizations), and algebraic geometry generalize key results and techniques from Euclidean geometry to both familiar and exotic settings. In algebraic and differential topology, techniques from diverse areas of mathematics are used to infer information about the shapes and related properties of spaces.



## Course : BMH2CC04

This subdivision of mathematics is not sharp: the areas of overlap between these main areas of mathematics are of great interest and importance. For example, analytic number theory as the study of the integers by means of tools from real and complex analysis, while differential geometry focuses on the interplay between analysis and geometry. The importance of all three areas, the influence of each on the others, and the insight to be gained by considering one area from perspectives commonly associated to another one are all emphasized in the Mathematics curriculum—as can be seen in the course matrix, many courses involve material from multiple areas.

## OBJECTIVES

The Mathematics Department offers few branches within the Mathematics major which has been depicted in the following:

### **Pure Mathematics :**

Students of our department start their bachelor degree course with the Pure Mathematics which has to be absorbed within three years of degree course designed by our Burdwan university and they usually feel the beauty of mathematics from the beginning of the course .The core course has been furnished so beautifully so that our students acquire every bit of pure mathematics from the beginning upto the last course the pathway emphasizes the importance of a well-rounded, in-depth mathematical education, and includes advanced coursework in number theory , algebra,

analysis, geometry and metric spaces.

### **Computational Mathematics:**

Students of our department learn Computational Mathematics track explore applications of mathematics in other fields and gain experience in mathematical modeling of real-world phenomena using ordinary and partial differential equations, approximation and optimization techniques, linear programming, or game theory. Students in the Mathematics Honours and General courses have to prepare for a career in different arena of mathematics solely or in wide range of mathematics related world ; students acquire in-depth knowledge of subjects covered at an introductory level in the classroom, including number theory, classical geometry, and the history of mathematics, and gain experience in teaching mathematics in an accessible and intuitive, but precise manner.

### **Applied Mathematics :**

Applied mathematics is the application of mathematical methods by different fields such as science, engineering, business, computer science, and industry. Thus, applied mathematics is a combination of mathematical science and specialized knowledge. The term "applied mathematics" also describes the professional specialty in which mathematicians work on practical problems by formulating and studying mathematical models. In the past, practical applications have motivated the development of mathematical theories, which then became the subject of study in pure mathematics where abstract concepts are studied for their own sake. The activity of applied mathematics is thus intimately connected with research in pure

mathematics .Historically, applied mathematics consisted principally of applied analysis, most notably differential equations; approximation theory (broadly construed, to include representations, asymptotic methods, variational methods, and numerical analysis); and applied probability. These areas of mathematics related directly to the development of Newtonian physics, and in fact, the distinction between mathematicians and physicists was not sharply drawn before the mid-19th century. This history left a pedagogical legacy in the United States: until the early 20th century, subjects such as classical mechanics were often taught in applied mathematics departments at American universities rather than in physics departments, and fluid mechanics may still be taught in applied mathematics departments.[1] Quantitative finance is now taught in mathematics departments across universities and mathematical finance is considered a full branch of applied mathematics.[2] Engineering and computer science departments have traditionally made use of applied mathematics. Today, the term "applied mathematics" is used in a broader sense. It includes the classical areas noted above as well as other areas that have become increasingly important in applications. Even fields such as number theory that are part of pure mathematics are now important in applications (such as cryptography), though they are not generally considered to be part of the field of applied mathematics per se. Sometimes, the term "applicable mathematics" is used to distinguish between the traditional applied mathematics that developed alongside physics and the many areas of mathematics that are applicable to real-world problems today. There is no consensus as to what the various branches of applied mathematics are. Such categorizations are made difficult by the way mathematics and science change over time, and also by the way universities organize departments, courses, and degrees. Our Burdwan university have organised this part very nicely in which our syllabus comprises Classical Mechanics , Hy-

drostatics , Dynamics of a particle, Rigid dynamics ,Linear programming Problem ,Game theory etc. and most interestingly this syllabus covers up each every details of these section in detail which must be helpful to our students .Our students are learning this part of the whole syllabus throughout the course in different years so that they can swallow up every concept, idea and technique in much detail.

### **Curriculum matrix :**

All of the key objectives are addressed to some extent in all courses. For example, the ability to formulate precise mathematical statements and to reason logically are essential skills that are progressively developed throughout the curriculum. However, some skills are more heavily emphasized and utilized in some courses than in others. Some courses are specifically intended to help students move to a new level of proficiency with a particular portfolio of skills, while others are accessible only to students who have already reached a given level; the latter courses make heavy use of particular skills, and thus enhance and reinforce the student's mastery of it, but the skills themselves are not the primary focus of such courses. We can observe very deep connections between the key objectives, main subject-specific areas, and courses which has been incorporated in our syllabus of the Bachelor degree mathematics course of our college.

### **Course Outcomes(Honours Courses)**

In the next we are furnishing the course outcomes of B.Sc CBCS Honours Course in Mathematics of Kalna College.

### **Course: BMH1CC01**

This includes a detail sketch on the basic concepts on Calculus, Analytical Geometry and Differential Equation. Students will get a flavour on various functions, their higher order derivatives, Leibnitz' rule, L'Hospital Rule, tracing of curves etc. which relate to different ideas on the applications of the previous mentioned concepts. This course talks about Reduction formulae for the integration of different functions and deals with parametrization of various curves, their arc-lengths to evaluate the area of surface revolution. Also it speaks off classification of conics, their polar equations with the help of co-ordinate transformations and talks about the equations of different three dimensional surfaces viz. spheres, cylindrical surfaces, quadric surfaces and their graphical representations. Lastly this section will cover the basic concepts of Ordinary Differential equations and its properties. Students will get ideas to solve exact differential equations using integrating factors.

### **Course: BMH1CC02**

In this section students will get a knowledge on basic properties of Complex Numbers and a very well-known De Moivre's theorem, theory of equations to solve cubic equations, biquadratic equations using well-known methods. This section gives a detail study on different Inequalities to use them in future study. Students will have a basic study on Number theory and various important properties of integers which includes congruence relation between integers. Also students will get concepts on the very important linear algebra, properties on matrices, vector spaces and their beautiful properties, characteristic polynomials, eigen values, eigen vectors etc.

### **Course: BMH2CC03**

This section the syllabus will give a basics of real number system and its important properties from which the students will get plenty of information regarding sets in  $\mathbb{R}$  and students may apply these concepts to the analysis of real numbers. These ideas will be applied to the convergence of sequences and infinite series. Students will learn the important Cauchy's convergence criterion for sequences and infinite series.

### **Course: BMH2CC04**

In this section students will be enriched with the general solution of homogeneous equation of second order, Linear homogeneous and non-homogeneous equations of higher order with constant co-efficients and also students will get knowledge on the beautiful concept of wronskian and their properties. These concepts will be applied to solve systems of linear differential equations and also to learn the basic theory of linear systems in normal form. With the help of these students will be able to solve differential equations by the use of power series about an ordinary point and about a regular singular point. Lastly vector analysis will help the students to study on the calculus on  $n$ -dimensional Euclidean space.

### **Course: BMH3CC05**

This section of the prescribed syllabus will put light on the basic notions of real analysis which starts from the limits of functions, continuity and uniform continuity and will give concepts on the properties of continuous functions and uniform continuous functions. After that a vast discussion on differentiability of a function at a point, Rolle's theorem and other mean-value theorems which will be applied to different inequalities, approximation of polynomials. Along this line students will be capable of

finding Taylor's series of many well-known functions. This section will also penetrate into the geometric counterpart of differential calculus. In the last portion students must be acquainted with the general notions of Metric spaces, neighbourhood of a point, open sets and several other concepts.

### **Course: BMH3CC06**

This prescribed part deals with the algebraic structure Group and its important properties. Also students will get notions of cyclic groups, abelian groups, Lagrange's theorem for finite groups. Some nice examples of Group viz. Symmetries of a square, Dihedral groups, Permutation groups etc. has been discussed including their important properties. Students will have a precise discussion on Direct product of groups which certainly help them to study finite abelian groups and their structure theorem. Also three well-known Isomorphism theorem for groups will have a strong impact to the students via some important problems.

### **Course: BMH3CC07**

This portion of the syllabus will cover up the numerical solution of transcendental and algebraic equation by differential methods and numerical solution of system of linear algebraic equations by different methods and ordinary differential equations. Students will get the concepts of Interpolations, numerical differentiation and integration by different rules. They also get practical ideas to solve the above numerical problems by using C-programming language.

### **Course: BMH3SEC11**

There are three different courses have been offered and amongst these students have chosen this course BMH3SEC11 which encounters Sets and Logic. Students must have an essence of basic set theory in a great detail and also they will face a strong impact of Mathematical logic.

### **Course: BMH4CC08**

This portion of the syllabus will cover up the Riemann integration theory through which students will be able to go into the beauty of integration theory, Improper integrals and will help them to solve many important problems which involves area, volumes etc. In the other part students will get concepts on the convergence problem of sequence of functions, series of functions and along this line they can use these ideas to investigate the properties of Fourier series, Bessel's inequality and lastly students may encounter some important features of Complex power series, radius of convergence of these series which links to Cauchy-Hadamard theorem, Differentiation and Integration of them.

### **Course: BMH4CC09**

This part will let the students know about the Functions of several variables which has a deep geometric nature in-built and the students will gather informations regarding double and triple integration of different specified regions which would help them to study further along this area and also they can rigorously use those to study Green's theorem, Stoke's theorem and Divergence theorem and their very nice applications.



**Course: BMH4CC10**

In this portion our students will be introduced to the Ring theory and some very important properties of fields which relates to the study of vector spaces. Students will hit problems on vector spaces, their dimension and also they will evaluate rank of Linear transformations using rank-nullity theorem. They will find some interesting properties on the linear transformations, their matrix representation, algebra of linear transformations and isomorphism theorems.

**Course: BMH4SEC21**

The students of our department have selected to study on Graph theory. The theory of Graphs is a very emerging branch in Mathematics and students will get benefit of this Graph theory. This portion will cover up the basics of Graph theory, some nice examples and construction of Graphs using different properties. Students will also get basic informations on Eulerian Graphs, Hamiltonian Graphs and their interesting properties which would help them to solve well-known problems on Graphs and these very useful concepts will be used in our modern networking sector and students will gather some informations regarding this also through the lectures.

**Course: BMH5CC11**

In this section, students will be enriched with Partial Differential Equation. Such equations arise in geometry and physics when the number of independent variables in the problem under consideration is two or more. This section gives a detailed study on solving heat equation, wave equation and Laplace equation by separation of variables and by using other methods. Students will also learn the concept of classification of 2nd order

PDE viz Hyperbolic, Parabolic or Elliptic, and reduction of these PDE into their respective canonical forms. This course also offers the Initial Boudary Value Problems.

### **Course: BMH5CC12**

In this section, students will get a detail study especially on Statics, Particle Dynamics and Rigid Dynamics. Here, students will learn the notion of friction which plays an important role in the mechanical problems related to our everyday life. If there were no friction between our legs and ground, we could never be able to walk. Also this section offers a detail study on virtual work, C.G. of different bodies, stable and unstable equilibrium. This course also deals with the concept of two dimensional motion, motion under inverse square law, motion of artificial satelite etc. Lastly, students will get ideas of moments and products of inertia, D'Alembert's principle and compound pendulum.

### **Course: BMH5DSE12**

This course has been framed to place some important advanced theory of Number theory. Firstly, it offers a detail study on Linear Diophantine equations, linear congruences and most importantly Chinese Remainder theorem. Also in this course we shall discuss on different number theoretic functions occurred naturally amongst which student will get a detail review on Euler's phi-function. Lastly we shall be able to throw some beautiful glimpses of notion on quadratic congruences and a very modern concept of public encryption and the course ends with the famous statement of Fermat's Last Theorem (FLT).

### **Course: BMH5DSE21**

This is a Discipline specific Elective course, there are three courses offered, our students have chosen this course BMH5DSE21 (Probability and Statistics). On completion of this course, the students will be able to distinguish between random and non-random experiments. They will learn the notion of conditional probability including the concept of Bayes' Theorem. They will acquire knowledge of important discrete distributions such as Binomial, Poisson, Geometric, Negative Binomial and also important continuous distributions such as Uniform, Normal, Gamma, Beta, Chi-square, t-distribution etc. They will gather knowledge about expectation and moments of such important distributions. Students will be able to find the correlation coefficient between two random variables and also regression lines of two variables. Students will learn the techniques of parameter estimation and tests of hypothesis.

### **Course: BMH6CC13**

On successful completion of this course, the students will be able to know that a Cauchy sequence in a metric space may not be convergent and hence they will learn about the complete metric spaces. The students will acquire knowledge about continuity of a function and will know the sequential criterion and other characterizations of continuity. They will learn about connectedness and connected subsets of reals. The students gather knowledge about compactness and its other equivalent definitions in metric spaces. They will know the necessary and sufficient condition for compactness in  $R^n$  that is the Heine-Borel theorem. Here the students will also know the very important theorem "Banach fixed point theorem". The students will be able to define a function of complex variable and carry out basic mathematical operations with complex numbers. The students

will learn the condition(s) for a complex variable function to be analytic and/or harmonic. They will know the Cauchy Riemann Equation and use it to show that a function is analytic. They will understand the concept of sequences and series with respect to the complex numbers system and establish whether a given series/sequence is convergent/divergent at a specified point or interval. The students will understand the concept of contour integral, they will also know some important beautiful theorems like Cauchy's theorem, Cauchy's integral formula, Cauchy-Goursat theorem, Liouville's theorem. The students will also be able to prove the fundamental theorem of Algebra.

### **Course: BMH6CC14**

In this course students will have a great deal of study on Polynomial rings and its different properties which includes some important irreducibility tests such as Eisenstein criterion and also we shall discuss some important characteristics of Unique Factorization Domains and Euclidean Domains. After that this course makes a detailed visit on diagonalizability of matrices, invariant subspaces whereas students will learn Cayley-Hamilton theorem and some other canonical forms by the use of minimal polynomial. Apart from these nice concepts we shall impart some discussion on beautiful concepts on inner product spaces in which we can construct an orthonormal basis in a finite dimensional vector space through the Gram-Schmidt orthogonalisation process and this section ends with a detailed discussion on normal and self-adjoint operators where we shall put light on spectral theorem.

## **DSE Courses:**

There are three different courses that have been offered in the 6th semester amongst which our students likely to choose the following two courses. These two courses has been furnished in such a way that will have some far reaching impacts.

### **Course: BMH6DSE33**

In this category there are three different courses that have been offered in the 6th semester amongst which our students likely to choose this course on group theory. In this course, students will get benefitted with the extended discussion on homomorphism of groups in which we shall give concepts of automorphism and inner automorphism of groups and we will compute automorphism groups for some nice groups such as cyclic groups of finite and infinite order. After making a visit on these concepts we will move forward to define direct product of finitely many groups which will be used to characterize finite abelian groups. Then we offer a brief course on group action and its important properties with some beautiful applications which includes generalised cayley's theorem and index theorem. Most importantly we shall discuss on sylow's theorem in finite groups through the impact of group actions and their different consequences which involves particularly Cauchy's theorem.

### **Course: BMH6DSE43**

In this category also there are three different courses that have been offered in the 6th semester amongst which our students likely to choose this one on Mechanics-II. Here students will gather information on Galilean transformation, limitation of newton's laws, constraints, Lagrange equation of motion of 1st and 2nd kind, Gibbs-Appell's principle of least square. In

this section, students will get a knowledge of pressure in a heavy homogeneous liquid, equilibrium of fluid, equilibrium of floating bodies, Isothermal and adiabatic changes in Gases and convective equilibrium.

## **Course Outcomes(General Courses)**

In this section we are furnishing the course outcomes of B.Sc CBCS General Course in Mathematics of Kalna College.

### **COURSE: BMG1CC1A**

In this portion of the syllabus, students will get a flavor on various functions, their higher order derivatives by Leibnitz's Rule, limiting value by L'Hospital Rule, and partial differentiability by Euler's theorem. By the help of differentiation, students may find tangent and normal, minimum and maximum value, Asymptotes, Curvature, Singularity, tracing of curves etc. they also will be able to observe the differentiability, continuity, nature of curves by Rolle's theorem, Mean value theorem and Taylor's theorem.

### **COURSE: BMG2CC1B**

In this section, students will be able to enrich with the various kinds of Ordinary Differential Equations and its properties. Students will get ideas to solve exact differential equations using integrating factors. Students can do solution of higher order differential equation, linear homogeneous equation with constant coefficient, linear non homogeneous equation and also students will get knowledge on the beautiful concept of Wronskian and their properties. Students also get the concept about Partial Differential Equation and they will be able to solve the problem with the help of

Lagrange's method and Charpit's method.

### **COURSE: BMG3CC1C**

In this section of the syllabus, students will get plenty of information regarding sets in  $\mathbb{R}$  and students may apply these concepts to the analysis of real numbers. These ideas will be applied to the convergence of sequence and infinite series. Students will learn the important Cauchy's convergence criterion for sequences and infinite series and they are able to test convergence and divergence of series by p-test, Comparison test, Root test, Ratio test and will get idea about alternating series and Leibnitz's test. The students also get idea about Power series and radius of convergence. In the last portion, students must be acquainted with the sequence and series of functions and results about uniform convergence, integrability and differentiability of functions.

### **COURSE: BMG4CC1D**

This prescribed part deals with the algebraic structure of Groups and its important properties. Students will get knowledge about abelian groups, sub-groups, Cyclic group, Lagrange's theorem for finite groups. Some nice examples of group are symmetries of a isosceles triangle, rectangle and square. Permutation groups has been discussed including their important properties. Students will get a precise discussion on Rings, Sub-rings and fields also.

### **COURSE: BMG4CC1D**

The students of our department have selected to study the Linear Programming. The Linear Programming is a very emerging branch in Mathematics and students will get benefit to solve the real life problems by

formulating and to present graphically on graphical method. Optimality is another interesting part of Linear Programming. Duality is the another interesting part where various problem are solved by Simplex Method, Big-M method and dual Simplex Method.

### **COURSE: BMG4SEC21**

In this portion our students will be introduced to Differentiation and Partial differentiation of a vector function, derivative of dot product and cross product of two vectors. Students will also accumulate knowledge about Gradient, divergence and curl.

#### **0.0.1 COURSE: BMG5DSE1A3**

In this section, students will get knowledge on Vector Spaces, Subspaces and their beautiful properties, characteristic polynomials, eigen values, eigen vectors, linear combination of vectors, basis and dimension of subspaces. Another interesting part of Linear Algebra is linear transformations. Students can get a wide knowledge about range, rank nullity of linear transformation, matrix representation of a linear transformation, algebra of linear transformation. Dual space, Dual basis, Isomorphism and well known Isomorphism theorem will have a strong impact on the students.

### **COURSE: BMG6SEC42**

In this part we shall be interested on Transportation problems and its different methods to solve this kind of Transportation problems like as Norwest-Corner method, least cost method and most importantly Vogel's approximation method of determining starting basic solution. Student will learn assignment problem by means of its mathematical formulation and



we shall be interested to study Hungarian method of solving assignment problem. Apart from these concept we move on discussing a new notion of Game Theory and its mathematical formulation. In this unit we will be learning a very interested concept of two person-zero sum games and their basic features. We teach on the games with mixed strategies and motivating our students to learn on graphical solution procedures.

Hence these are all course outcomes for Undergraduate Mathematics Course for both Honours and General Mode in the syllabus framed by The University of Burdwan.