Program: M.Sc. Mathematics

Program Outcomes (PO)

PO1. Demonstrate an advanced knowledge and fundamental understanding of a number of specialist mathematical topics, including the ability to solve problems related to those topics using appropriate techniques.

PO2. Motivate for research in Mathematical sciences and to apply rigorous, analytic, highly numerate approach to analyze, execute tasks and solve problems in daily life and at work.

PO3. Provide a systematic understanding of core Mathematical concepts, Principles and theories along with their applications.

PO4. It evaluates how the various sub-disciplines are inter related, the ability to use techniques from different areas and in-depth knowledge about chosen topics.

PO5. Communicate clearly in writing and orally knowledge, ideas and conclusions about mathematics including formulating complex mathematical arguments using abstract mathematical thinking synthesizing intuition about mathematical ideas and their applications.

PO6. To be able to independently read mathematical and statistical literature of various types including survey articles, scholarly books and online e-resources.

PO7. Evaluate hypothesis, theories, methods and evidence within their proper contexts.

PO8. Demonstrate engagement with current research and developments in the program.

Program Specific Outcomes (PSO)

PSO1. A research oriented learning that develops analytical and integrative problem solving approaches.

PSO2. Create, select and apply appropriate techniques, resources and modern technology in multi-disciplinary environment.

PSO3. Career Opportunities exist in teaching in Schools & Colleges (after M.Sc., B.ed/Net/PhD) where any of the science subjects is an important discipline.

PSO4. Careers in Indian Administrative services, other States and Central Govt. services where knowledge of Mathematics is an advantage.

Course Outcomes

Course Name: Real Analysis I
Class: M.Sc Semester: I

Course Objectives:
The aim of the course is to demonstrate theoretical knowledge and have practical skills in the subject of advanced real analysis. Demonstrate an ability to initiate and sustain in-depth research relevant to real analysis. Furthermore, The course includes axioms of real number systems, uniform convergence of sequences and series of functions, equicontinuity, compact and complete metric spaces, the inverse function theorem, the Weierstrass theorem and contraction maps.

Course Outcomes:

A. **Knowledge and Understanding:**
Students will
- Recognize the contribution and impacts of real analysis in different areas of science.
- Identify the steps required to carry out a piece of research on a topic within real analysis.
- The theories and concepts used in the real analysis.
- Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.

B. **Intellectual(cognitive/Analytical) skills:**

- Apply appropriate theories, principles and concepts relevant to the real analysis.
- Assess and evaluate the literature within real analysis.
- Think independently and develop the ability to self appraise and reflect on scientific data Arabic and in English relevant to real analysis.
- Use appropriate effective written and oral communication learning relevant to the topics in the course of real analysis.
- Demonstrate an appropriate judgment in selecting and presenting information using various methods relevant to real analysis.

C. **Practical skills:**

- Plan and design practical activities using techniques and procedures appropriate to real analysis.
- Plan and design a piece of independent research using real analysis media and techniques.
- Work effectively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to these topics.
- Deal with problems relevant to real analysis topics using ideas and techniques some of which are at the forefront of the discipline.

Course Name: Complex Analysis
Class: M.Sc. Semester: I

Course Objectives:
The aim of the course is to introduce the fundamental idea of the functions of complex variables and developing a clear understanding of the fundamental concepts of complex analysis such as analytic functions, complex integrals and a range of skills which will allow students to work effectively with the concepts.

Course Outcomes:

D. Knowledge and Understanding:

Student will able to

- Understand the complex numbers provide a satisfying extension of the real numbers.
- Determine whether a given function is differentiable and if so find its derivative.
- Use Power series and line integral to construct differentiable functions.
- Use residue theorem to compute several kinds of real integrals.
- Construct conformal mappings between many kinds of domain.

E. Intellectual (cognitive/Analytical) skills:

- Explain the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of complex analysis techniques.
- Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining from complex analysis.

F. Practical skills:

- Appreciate how mathematics is used in design such as conformal mapping.
- Learn techniques of complex analysis that make practical problems easy, e.g. graphical rotation and scaling as an example of complex multiplication.
- Appreciate how throwing problems into a more general context may enlighten one about a specific context (e.g. solving real integrals by doing complex integration.
- Taylor series of a complex variable illuminating the relationship between real function that seem unrelated-e.g. exponentials and trig functions.
- Apply program solving using complex analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts.

Course Name: Algebra I
Class: M.Sc. Semester: I

Course Objectives:

This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

The focus of the course will be the study of certain structures called groups, rings, fields and some related structures.

Course Outcomes:

G. Knowledge and Understanding:

- Students will gain experience and confidence in proving theorems. A blended teaching method will be used requiring the students to prove theorems give the student the experience and knowledge.
- Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and Abelian groups.
- Students will see and understand the connection and transition between previously studied mathematics and more advanced mathematics.
- The students will actively participate in the transition of important concepts such homeomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.

H. Intellectual(cognitive/Analytical) skills:

Students will be

- Acquire communication and organizational skills, including effective written communication in their weekly assignments.
- Able to employ the concepts and methods described in the syllabus.
- Able to follow complex logical arguments and develop modest logical arguments.

I. General skills:

- Use organizational skills (including task and time management) relevant to modern algebra individually and in group situation.
- Communicate with other positively with problems relevant to problems in modern algebra.
- Solve problems relevant to modern algebra.

Course Name: Mechanics I
Class: M.Sc. Semester: I

Course Objectives:

Mechanics is the study of the physics of motion and how it related to applied forces. It lays the foundation of understanding the world around us through the how and why of motion.The main

goal of the course is to introduce students to classical mechanics and its applications and for them to learn the fundamentals of this important topic

Course outcomes:

J. Knowledge and Understanding:

- Define the characteristics and calculate the magnitude of selected mechanical properties of materials.
- Describe the basic concepts and principles and perform relevant calculations with respect to the mechanical properties of materials as they relate to problems of strength and stability of structures and mechanical components.

K. Intellectual(cognitive/Analytical) skills:

In order to pass the course the student should be able to

- Give an account of the foundations of calculus of variations and of its applications in mathematics and physics.
- solve simple initial and boundary value problems by using several variable calculus;
- Formulate maximum principles for various equations and derive consequences.
- Illustrate the laws of motion, kinematics of motion and their interrelationship.
- Formulate important results and theorems covered by the course.
- Use the theory, methods and techniques of the course to solve problems.

L. Practical skills:

- Parameters defining the motion of mechanical systems and their degrees of freedom.
- Application of the vector theorems of mechanics and interpretation of their results.
- Introduction to analytical mechanics as a systematic tool for problem solving.
- Study of the interaction of forces between solids in mechanical systems.
- Apply Newton's laws of motion and conservation principles.

Course Name: Differential Equations
Class: M.Sc. Semester: I

Course Objectives:

The aim of the course is to study differential equations and to know that what is the relationship between the partial differential equations and ordinary differential equations and how to solve homogenous and non- homogenous differential equations by different methods with some problems..

Course Outcomes:

M. Knowledge and Understanding:

Students will know

- Explore the methods of solutions of boundary value problems.
  Investigate systems of ordinary differential equations.
  Model with first-order differential equations (DE) and identify initial value problem.
- Calculate both real and complex forms of the Fourier series for standard periodic waveforms and convert from real-form Fourier series to complex-form and vice-versa.
- Develop essential methods of obtaining solutions of classical partial differential equations.

N. Intellectual(cognitive/Analytical) skills:

- Obtain solutions for ordinary differential equations whose non homogeneous terms include discontinuous functions or distributions.
- Obtain solutions for systems of ordinary differential equations using various tools of linear algebra.
- Recognize even and odd functions and use the resulting simplifications for Fourier series and transforms

O. Practical skills:

- Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems.
- Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.
- Work with ODEs and systems of ODEs in various situations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving ODEs and systems of ODEs with colleagues in the field of mathematics, science or engineering.

Course Name: Real Analysis II
Class: M.Sc. Mathematics Semester: II

Course Objectives:

The aim of the course is to demonstrate theoretical knowledge and have practical skills in the subject of advanced real analysis. Demonstrate an ability to initiate and sustain in-depth research relevant to real analysis. Furthermore, in this course the students will develop a proper understanding of measurable functions, measures and the Lebesgue integral. Given these concepts they will consider various concepts of convergence of measurable functions and the convergence of the corresponding integrals, changes of measures and spaces of integrable function.

Course Outcomes:

P. Knowledge and Understanding:

Students will know

- The theories and concepts used in the real analysis.
- Identify the steps required to carry out a piece of research on a topic within real analysis.
- Recognize the contribution and impacts of real analysis in different areas of science.

Q. Intellectual(cognitive/Analytical) skills:

- Apply appropriate theories, principles and concepts relevant to the real analysis.
- Assess and evaluate the literature within real analysis.
- Demonstrate an appropriate judgment in selecting and presenting information using various methods relevant to real analysis.

R. Practical skills:

- Plan and design practical activities using techniques and procedures appropriate to real analysis.
- Plan and design a piece of independent research using real analysis media and techniques.

S. General skills:

- Use appropriate effective written and oral communication learning relevant to the topics in the course of real analysis.
- Work effectively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to these topics.
- Deal with problems relevant to real analysis topics using ideas and techniques some of which are at the forefront of the discipline.
- Think independently and develop the ability to self appraise and reflect on scientific data Arabic and in English relevant to real analysis.

Course Name: Differential and Integral Equations
Class: M.Sc. Semester: II

Course Objectives:

The aim of the course is to study integral equations and to know that what is the relationship between the integral equations and ordinary differential equations and how to solve linear and non- linear integral equations by different methods with some problems which give rise to integral equations.

Course Outcomes:

T. Knowledge and Understanding:

Students will know

- Model with first-order differential equations (DE) and identify initial value problems
- Explore the use of partial differential equations as models for processes of heat transfer, wave propagation, and diffusion.

- Develop essential methods of obtaining solutions of classical partial differential equations.
- Explore the methods of solutions of boundary value problems.
  Investigate systems of ordinary differential equations.

U. Intellectual(cognitive/Analytical) skills:

- Obtain solutions for ordinary differential equations whose non homogeneous terms include discontinuous functions or distributions.
- Solve classical partial differential equations such as the heat equation, wave equation, Laplace's equation, and Poisson's equation by various methods.
- Obtain solutions for systems of ordinary differential equations using various tools of linear algebra.

V. Practical skills:

- Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems.
- Demonstrate their ability to write coherent mathematical proofs and scientific arguments needed to communicate the results obtained from differential equation models.

Course Name: Tensors and Differential Geometry
Class: M.SC Semester: II
Course Objectives:
The aim of the course is to provide for the students an introduction to theory of tensors which is a classical subject in multi linear algebra and differential geometry. The course focuses on the basic concept of tensor products of vector spaces and operators, various notions of tensor ranks. Furthermore, this course introduces students to the key concepts and techniques of differential geometry.

Program Learning Outcomes:

(Knowledge and understanding, Intellectual skills, practical skills)
Learning outcomes:

W. Knowledge and Understanding:
Student will know

- Scalar and cross product of vectors in 2 and 3 dimensions represented as differential forms or tensors.
- The vector-valued functions of a real variable and their curves and in turn the geometry of such curves including curvature, torsion and the Serret-Frenet frame and intrinsic geometry,
- Scalar and vector valued functions of 2 and 3 variables and surfaces, and in turn the geometry of surfaces

- The differential ideas of divergence, curl, and the Laplacian along with their physical interpretations, using differential forms or tensors to represent derivative operations.

X. Intellectual (cognitive/Analytical) skills:

- State definitions and theorems and present standard proofs accurately without access to notes/books.
- Perform local calculations in differential geometry accurately (tensor calculus, covariant derivatives, Lie derivatives).
- Calculate curvature tensors for simple space times.
- Derive and solve the geodesic equations for simple space times.

Y. Practical skills:

- Apply theory developed in the course to solve unseen problems.
- Integral curves of vector fields and solving differential equations to find such curves.
- The differential ideas of divergence, curl, and the Laplacian along with their physical interpretations, using differential forms or tensors to represent derivative operations,

Course Name: Algebra II
Class: M.Sc. Semester: II

Course Objectives:
This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

Course Outcomes:

Z. Knowledge and Understanding:

- Students will be introduced to and have knowledge of many mathematical concepts studied in abstract mathematics such as permutation groups, factor groups and Abelian groups.
- Students will see and understand the connection and transition between previously studied mathematics and more advanced mathematics.
- The students will actively participate in the transition of important concepts such homeomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.
- Students will gain experience and confidence in proving theorems. A blended teaching method will be used requiring the students to prove theorems give the student the experience and knowledge.

AA. Intellectual(cognitive/Analytical) skills:

Students will be

- Able to employ the concepts and methods described in the syllabus.
- Acquire communication and organizational skills, including effective written communication in their weekly assignments.
- Able to follow complex logical arguments and develop modest logical arguments.

BB. General skills:

- Communicate with other positively with problems relevant to problems in modern algebra.
- Use organizational skills (including task and time management) relevant to modern algebra individually and in group situation.
- Solve problems relevant to modern algebra.

Course Name: Mechanics II

Class: M.Sc. Semester: II

Course Objectives:

Mechanics is the study of the physics of motion and how it related to applied forces. It lays the foundation of understanding the world around us through the how and why of motion. The second module that covers calculus based mechanics.

Calculus of Variations deals with optimization problems where the variables, instead of being finite dimensional as in ordinary calculus, are functions. This course treats the foundations of calculus of variations and gives examples on some (classical and modern) applications within physics and engineering science.

Course Outcomes:

CC. Knowledge and Understanding:

- Define the characteristics and calculate the magnitude of selected mechanical properties of materials.
- Describe the basic concepts and principles and perform relevant calculations with respect to the mechanical properties of materials as they relate to problems of strength and stability of structures and mechanical components.

DD. Intellectual(cognitive/Analytical) skills:

In order to pass the course the student should be able to

- Give an account of the foundations of calculus of variations and of its applications in mathematics and physics.
- Describe the brachistochrone problem mathematically and solve it.
- Solve isoperimetric problems of standard type.
- solve simple initial and boundary value problems by using several variable calculus;

- Formulate maximum principles for various equations and derive consequences.
- Formulate important results and theorems covered by the course.
- Use the theory, methods and techniques of the course to solve problems.

EE. Practical skills:

-Relative motion. Inertial and non inertial reference frames.
-Parameters defining the motion of mechanical systems and their degrees of freedom.
-Study of the interaction of forces between solids in mechanical systems.
- Centre of mass and inertia tensor of mechanical systems.
-Application of the vector theorems of mechanics and interpretation of their results.
-Newton's laws of motion and conservation principles.
-Introduction to analytical mechanics as a systematic tool for problem solving..

Course Name: Functional Analysis I
Class: M.Sc. Semester: III
Course Objectives:
The objective of this course is to demonstrate theoretical knowledge and have practical skills in the theory of analysis. Demonstrate an ability to initiate and sustain in-depth research relevant to functional analysis. Have an opportunity to put theory into practice via applications of functional analysis on real life problems.

Course Outcomes:

A. Knowledge and Understanding:
- Identify the steps required to carry out a piece of research on a topic within functional analysis.
- Summarize the theories and concepts used in the functional analysis.
- Demonstrate a reasoned argument to the solution of familiar and unfamiliar problems relevant to functional analysis.

B. Intellectual (cognitive/Analytical) skills:
- Apply appropriate theories, principles and concepts relevant to the functional analysis.
- Assess and evaluate the literature within functional analysis.
- Deal with appropriate effective written and oral communication skills relevant to functional analysis

C. Professional skills:
- Plan practical activities using techniques and procedures appropriate to functional analysis.

- Execute a piece of independent research using functional analysis media and techniques
- Recognize the contribution and impacts of functional analysis in applied science.
- Work effectively as a part of group, involving leadership, group dynamics relevant to functional analysis.

Course Name: Topology I
Class: M.Sc. Semester: III

Course Objectives:
The aim of the course is to provide for the students an introduction to theory of metric and topological spaces with emphasis on those topics that are important to higher mathematics. The course focuses on the basic notions of metric and topological spaces, properties of continuous mappings selected types of topological spaces (connected spaces) and basic theorems on topological spaces.

Course Outcomes:

A. Knowledge and Understanding:
- Know how the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighborhoods at each point, and you know what it means for a function to be continuous
- Identify the steps required to carry out a piece of research on a topic within Mathematical Logic and Topology.
- Recognize the contribution and impacts of Mathematical Logic and Topology in real life problem.

B. Intellectual(cognitive/Analytical) skills:

- Apply appropriate theories, principles and concepts relevant to the Topology.
- Formulate a reasoned argument from a variety of sources.
- Analyze and interpret information from a variety of sources relevant to Mathematical Logic and Topology.
- Select a reasoned argument to the solution of familiar and unfamiliar problems relevant to Topology.
- Familiar with the Urysohn lemma and the Tietze extension theorem, and you can characterise metrizable spaces.

C. General skills:
- Think independently, Set tasks and solve problems on ethical scientific basis relevant to Topology.
- Communicate with others positively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to Mathematical Logic and Topology.

- Use information and communication technology to discuss problems relevant to Topology.
- Student is able to apply his or her knowledge of general topology to formulate and solve problems of a topological nature in mathematics and other fields where topological issues arise.

Course Name: Statistics I
Class: M.Sc. Semester: III

Course Objectives:
Recognize important differences between descriptive and inferential statistics; distinguish between different types of variables and data; summarize, organize, tabulate and graph statistical data; read and understand statistical data present in various forms of the media; find and analyze measures of center and variation for quantitative data.

Course Outcomes:

D. Knowledge and Understanding:
Students will be able to
- Students will formulate complete, concise, and correct mathematical proofs.
- Students will frame problems using multiple mathematical and statistical representations of relevant structures and relationships and solve using standard techniques.
- Students will create quantitative models to solve real world problems in appropriate contexts.

E. Intellectual(cognitive/Analytical) skills:
- Students will effectively use professional level technology tools to support the study of mathematics and statistics.
- Students will clearly communicate quantitative ideas both orally and in writing to a range of audiences.

F. Practical skills:
- Students will be able to compete successfully for internship and employment positions in government, industry, and non-profit organizations.
- Students will have a predisposition for outreach toward application areas such as physical sciences, financial services, and social sciences and have the knowledge, experience, and motivation to bring the tools of mathematics and statistics to bear on real-world problems.
- Students will have the intellectual curiosity and flexibility to grow with developing technology and new methods mathematics and statistics.

Course Name: Operations Research I

Class: M.Sc. Semester: III

Course Objectives:

The objectives of this course is to introduce students to the technique of operation research in mining operation, provide students with skills and knowledge of operation research and its applications in mineral industry and introduce students to practical applications of operation research in big mining projects.

Course Outcomes:

G. Knowledge and Understanding:

The students will be able to

- Apply the techniques used in operation research to solve real life problem.
- Explain the meaning of operation research.
- Know the various techniques of operation research.
- Use some solution methods for solving the nonlinear optimization problems.

H. Intellectual(cognitive/Analytical) skills:

Use operation research to:

- Eliminate customers/clients waiting period for service delivery.
- Illustrate how queuing theory can solve problems with inter-arrival and service times exponentially distributed using operation research.
- Solve transportation problems during the allocation of truck to excavators.

I. Practical skills:

- Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.
- Identify and develop operational research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimisation problems. Use mathematical software to solve the proposed models.

Course Name: Integral Transforms

Class: M.Sc. Semester: III

Course Objectives:

The course is aimed at exposing the students to learn the Laplace transforms and Fourier transforms. To equipped with the methods of finding Laplace transform and Fourier Transforms of different functions. To make them familiar with the methods of solving differential equations, partial differential equations, IVP and BVP using Laplace transforms and Fourier transforms.

Course Outcomes:

J. Knowledge and Understanding:

On completion of this course, the learner will be able to:

- Calculate the Laplace transform of standard functions both from the definition and by using tables.
- Demonstrate their understanding of the Dirichlet conditions by using them to evaluate infinite series.
- Compute the Z transform of elementary sequences both from the definition and by using tables and use the appropriate theorems to calculate Z transforms and inverse Z transforms.

K. Intellectual(cognitive/Analytical) skills:

- Calculate both real and complex forms of the Fourier series for standard periodic waveforms and convert from real-form Fourier series to complex-form and vice-versa.
- Select and combine the necessary Z transform techniques to solve second-order ordinary difference equations.
- Recognize even and odd functions and use the resulting simplifications for Fourier series and transforms.

L. Logical skills:

- Present his/her calculations in a manner that is readily intelligible.
- Approach more advanced aspects of transform methods.
- Select and combine the necessary Laplace transform techniques to solve second-order ordinary differential equations.

Course Name: Functional Analysis II
Class: M.Sc. Mathematics Semester: IV

Course Objectives:

Demonstrate theoretical knowledge and have practical skills in the theory of analysis.
Demonstrate an ability to initiate and sustain in-depth research relevant to functional analysis.
Have an opportunity to put theory into practice via applications of functional analysis on real life problems.

Course Outcomes:

D. Knowledge and Understanding:

- Summarize the theories and concepts used in the functional analysis.
- Identify the steps required to carry out a piece of research on a topic within functional analysis.
- Recognize the contribution and impacts of functional analysis in applied science.

E. Intellectual (cognitive/Analytical) skills:

- Apply appropriate theories, principles and concepts relevant to the functional analysis.
- Demonstrate a reasoned argument to the solution of familiar and unfamiliar problems relevant to functional analysis.
- Assess and evaluate the literature within functional analysis

F. Professional skills:

- Plan practical activities using techniques and procedures appropriate to functional analysis.
- Execute a piece of independent research using functional analysis media and techniques.

G. General skills:

- Deal with appropriate effective written and oral communication skills relevant to functional analysis.
- Work effectively as a part of group, involving leadership, group dynamics relevant to functional analysis.

Course Name: Topology II
Class: M.Sc. Semester: IV
Course Objectives:
The aim of the course is to provide for the students an introduction to theory of metric and topological spaces with emphasis on those topics that are important to higher mathematics. The course focuses on the basic notions of metric and topological spaces, properties of continuous mappings selected types of topological spaces (compact and connected spaces) and basic theorems on topological spaces.

Course Outcomes:

M. Knowledge and Understanding:

- Mention theories and concepts used in Mathematical Logic and Topology.
- Identify the steps required to carry out a piece of research on a topic within Mathematical Logic and Topology.
- Recognize the contribution and impacts of Mathematical Logic and Topology in real life problem.

N. Intellectual(cognitive/Analytical) skills:

- Apply appropriate theories, principles and concepts relevant to the Topology.
- Formulate a reasoned argument from a variety of sources.
- Analyze and interpret information from a variety of sources relevant to Mathematical Logic and Topology.
- Select a reasoned argument to the solution of familiar and unfamiliar problems relevant to Topology.

O. General skills:

- Think independently, Set tasks and solve problems on ethical scientific basis relevant to Topology.
- Communicate with others positively as part of a group, involving leadership, group dynamics and interpersonal skills such as listening, negotiation and persuasion relevant to Mathematical Logic and Topology.
- Use information and communication technology to discuss problems relevant to Topology.

Course Name: Statistics II
Class: M.Sc Semester: IV

Course Objectives:
Recognize important differences between descriptive and inferential statistics; distinguish between different types of variables and data; summarize, organize, tabulate and graph statistical data; read and understand statistical data present in various forms of the media; find and analyze measures of center and variation for quantitative data.

Course Outcomes:

P. Knowledge and Understanding:
Students will be able to
- Calculate a critical value from a normal, t, chi - square, and f distribution.
- Calculate an appropriate confidence interval for a population parameter for a given data set.
- Perform an appropriate hypothesis tests for a population parameter for a given data set.
- Perform a Chi - Square Test of Independence for a contingency table.
- calculate a linear regression for a given data set

Q. Intellectual(cognitive/Analytical) skills:
- Understand, apply and compute in one- and two- sample estimation problems.
- Understand, apply and compute in one- and two- sample tests of hypotheses problems.
- Recognize the relationship between the confidence interval estimation and tests of hypothesis.
- Understand, apply and examine the goodness-of-fit test, test for independence and homogeneity.
- Recognize the basic concepts of simple linear regression and correlation.
- Recognize the concept of the analysis-of-variance technique and the strategy of experimental design.

R. Practical skills:

- Students will be able to compete successfully for internship and employment positions in government, industry, and non-profit organizations.
- Students will have a predisposition for outreach toward application areas such as physical sciences, financial services, and social sciences and have the knowledge, experience, and motivation to bring the tools of mathematics and statistics to bear on real-world problems.
- Students will have the intellectual curiosity and flexibility to grow with developing technology and new methods mathematics and statistics.

Course Name: Operations Research II
Class: M.Sc Semester: IV
Course Objectives:
The objectives of this course is to introduce students to the technique of operation research in mining operation, provide students with skills and knowledge of operation research and its applications in mineral industry and introduce students to practical applications of operation research in big mining projects.

Course Outcomes:

S. Knowledge and Understanding:

The students will be able to

- Explain the meaning of operation research.
- Know the various techniques of operation research.
- Select an optimum solution with profit maximization.
- Apply the techniques used in operation research to solve real life problem.

T. Intellectual(cognitive/Analytical) skills:

Use operation research to:

- Eliminate customers/clients waiting period for service delivery.
- Illustrate how queuing theory can solve problems with inter-arrival and service times exponentially distributed using operation research.
- Solve transportation problems during the allocation of truck to excavators.

U. Practical skills:

- Identify and develop operational research models from the verbal description of the real system.
- Understand the mathematical tools that are needed to solve optimisation problems. Use mathematical software to solve the proposed models.

- Develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

Course Name: Discrete Mathematics I
Class: M.Sc. Semester: IV

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of discrete mathematics by being able to do use of mathematically correct terminology and notation, construct correct direct and indirect proofs, and use division into cases in a proof and apply logical reasoning to solve a variety of problems.

Course Outcomes:

V. Knowledge and Understanding:
- Simplify and evaluate basic logic statements including compound statements, implications, inverses, converses.
- Get the knowledge discrete and non-discrete function, graph function, identify one to-one functions, and perform the composition of functions.
- Understanding of how to apply algorithms to problems including searching algorithm, base conversion algorithms and the Euclidean algorithm.
- Express a logic sentence in terms of predicates, quantifiers and logical connectives.

W. Intellectual(cognitive/Analytical) skills:
- Solve counting problems involving the multiplication rule, permutation and combination.
- State the definitions of binary relation, reflexive, symmetric, transitive, equivalence relation, equivalence class, class representative and partitions.
- Connection between cardinality of sets and one-to-one correspondences, and be able to prove two sets have the same cardinality.

X. Logical skills:
- Apply rules of inference, tests for validity and methods of proofs including direct and indirect proof forms, proof by contradiction, and proof by cases and mathematical induction.
- Evaluate Boolean functions and simplify expression using the properties of Boolean algebra, apply Boolean algebra to circuits and gating networks.
- Determine if a graph is a binary tree, N-array tree, or not a tree; use the properties of tress to classify trees, identify ancestors, descendants, parents, children and siblings.