DEPARTMENT OF MATHEMATICS
FACULTY OF SCIENCE
JAGANNATH UNIVERSITY, DHAKA

Curriculum for the Degree of Bachelor of Science
B.Sc.(Honours) in Mathematics
Session: 2020-2021 and Onwards

Prepared by

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Department of Mathematics
Jagannath University, Dhaka
Curriculum for the Session: 2020-2021 and Onwards

Department of Mathematics is one of the most active disciplines under the faculty of Science and offers relevant courses to produce highly skilled graduates with theoretical and well-equipped practical knowledge. Courses of study for a Bachelor of Science (Honours) degree in Mathematics shall extend throughout 4 (four) academic years and each academic year shall be divided into 2 (two) semesters. As a result, the whole course of study shall be divided into 8 (eight) semesters. A Semester is conducted for 6 (six) months named as *1st Semester* and *2nd Semester* in each academic year. Examinations shall be held at the end of each semester.

A student of the Bachelor's program in Mathematics shall have to complete all 58 (fifty-eight) courses (147credits) listed in the curriculum. Of the 58 courses, there will have 45 (forty-five) theoretical courses (120 credits), 8 (Eight) Lab courses (19 credits), 4 (four) viva-voce courses (8 credits) and 1 honours project (03 credits). Among the courses offered, a student shall have to complete a total of 3 (three) courses (6 credits) related to Physics, 3 theory courses (6 credits) and 3 practical courses (6 credits) related to Computer science, 2 courses (6 credits) related to Statistics, 1 course (3 credits) related to English and 1 course (3 credits) related to Humanities as an integrated course.

Assignment of Credits:

Theoretical Course: A 3 credits course will involve three lecture hours per week (a total of 45 lecture hours) and a 2 credits course will involve two lecture hours per week (a total of 30 lecture hours).

Practical Course: A 3 credits course will involve three lecture hours per week (a total of 45 lecture hours) and a 2 credits course will involve two lecture hours per week (a total of 30 lecture hours).

Marks Distribution: Of the total marks in a theoretical or a practical course, 70% will be from the written/practical examination to be held at the end of the course as a final examination and 30% as a continuous assessment. Among the 30% marks of continuous assessment for Theoretical courses, two mid-semester examinations and class attendance/performance are included. On the other hand, among the 30% marks of continuous assessment for Practical courses, participation and performance/Oral test/Assignment/Oral/Written test on Laboratory-Work/Field-Work/Internship/Project /Research and class attendance are included. Detailed marks distribution for each course can be found inside the curriculum.

1. Program Name:

B.Sc. (Honours) in Mathematics

2. Vision:

The Department of Mathematics at Jagannath University strives to be an internationally recognized center of excellence in teaching and research. To achieve this vision, the department is committed to provide study courses for undergraduate and graduate students in mathematics that ensure curriculum, scholarship opportunities, innovative engagement opportunities that meet high quality and intellectual challenges.

3. Mission:
The Department of Mathematics at Jagannath University is dedicated to achieving quality education through an active learning process and encourages personal and intellectual growth to prepare students for a dynamic career, meaningful life and global context.

4. Overview of the program offering entity:
The Department of Mathematics is one of the most active departments under the Faculty of Science and offers relevant courses to produce highly skilled graduates with theoretical and well-equipped practical knowledge. It focuses on providing sufficient opportunities to work with relevant instrumentation, to learn experiment designing, execution, analysis and troubleshooting in solving practical problems. The topics are integrated throughout the core mathematics courses, lab experiences, and the courses in non-science fields provide our students with the background information necessary to make informed decisions concerning mathematical and socio-economic issues in this complex life.

5. Learning Outcomes of the Program:
The graduates would be able to-

- plan, design and implement individual research;
- share scientific knowledge among the scientists;
- collect, analyze and present results with confidence;
- arrange, conduct and interact lively in seminar and workshop;
- apply their acquired knowledge in different domains of the mathematical world;
- recognize and solve the problems in mathematical sciences;
- decide correctly by analyzing the situation in their respective field;
- communicate knowledge and technology;
- establish an interpersonal relationship and work in a team;
- control emotions to keep them honest;
- serve the country as per need;

6. Course Structure:

Program duration: 4 Years
Numbers of Semester: 8
Semester Duration: 6 Months
Total number of credit hours available: 147
Minimum credit hours to be earned: 147
Earn a minimum CGPA: 2.25
Complete the program within six academic years of his/her 1st admission year into the program.

6.1 Summary of the total available credits (core and related) from different areas of study:

Distribution of credits in different areas of study

Areas of study	Theory	Practical	Viva-voce	Total
Mathematics	96	13	8	117
English	3	---	---	3
Computer Science	6	6	---	12
Physics	6	---	---	6
Statistics	6			6

Humanities	3	---	---	3
Total	120	19	8	147

Year-wise distribution of credits:

Year	Semester	Theory		Practical		Viva-voce	Total
		Major	**Related**	**Major**	**Related**		
First	**First**	7	7	---	2	---	16
	Second	7	5	3	---	2	17
Second	**First**	10	4	2	2	---	18
	Second	6	5	3	2	2	18
Third	**First**	16	3	---	---	---	19
	Second	14	--	2	---	2	18
Fourth	**First**	21	---	-	---	---	21
	Second	15	---	3	---	2	20
Total		96	24	13	6	8	147

6.2 The duration of the final examination for theoretical and practical courses shall be as follows:

Theory Examination		Practical Examination	
Course marks (Credit)	**Examination hour(s)**	**Course marks (Credit)**	**Examination hour(s)**
35 (2)	2 hours	35 (2)	2 hours
70 (3)	3 hours	70 (3)	3 hours

6.3 Course outline:
Semester-wise course outline for the entire program:

1st Year 1st Semester

Course Code	Course Title	Marks	Credits
MTH 1101	Fundamentals of Mathematics	50	02
MTH 1102	Calculus I	100	03
MTH 1103	Two Dimensional Geometry	50	02
MTHR 1104	Fundamental English	100	03
MTHR 1105	Mechanics and Properties of Matter	50	02
MTHR 1106	Introduction to Computer Application	50	02
MTHR 1107	Introduction to Computer Application Lab	50	02
		Total Credits	16

1st Year 2ndSemester

Course Code	Course Title	Marks	Credits
MTH 1201	Basic Algebra	50	02
MTH 1202	Calculus II	100	03
MTH 1203	Three- Dimensional & Vector Geometry	50	02

MTHL 1204	Mathematics Lab I	100	03
MTHV 1205	Viva-Voce	50	02
MTHR 1206	Electricity, Magnetism and Optics	50	02
MTHR 1207	Introduction to Statistics and Probabilities	100	03
		Total Credits	17

2nd Year 1st Semester

Course Code	Course Title	Marks	Credits
MTH 2101	Calculus III	50	02
MTH 2102	FORTRAN Programming	100	03
MTH 2103	Ordinary Differential Equations I	100	03
MTHL 2104	FORTRAN Programming Lab I	50	02
MTHR 2105	Atomic and Nuclear Physics	50	02
MTHR 2106	History of the Liberation War of Bangladesh	100	03
MTHR 2107	Structured Programming Language	50	02
MTHR 2108	Structured Programming Language Lab	50	02
		Total Credits	19

2nd Year 2nd Semester

Course Code	Course Title	Marks	Credits
MTH 2201	Calculus IV	50	02
MTH 2202	Linear Algebra I	50	02
MTH 2203	Numerical Analysis I	50	02
MTHL 2204	Mathematics Lab II	100	03
MTHV 2205	Viva-Voce	50	02
MTHR 2206	Methods of Statistics	100	03
MTHR 2207	Data Structure	50	02
MTHR 2208	Data Structure Lab	50	02
		Total Credits	18

3rd Year 1st Semester

Course Code	Course Title	Marks	Credits
MTH 3101	Abstract Algebra I	100	03
MTH 3102	Real Analysis I	100	03
MTH 3103	Complex Analysis	100	03
MTH 3104	Ordinary Differential Equations II	100	03
MTH 3105	Numerical Analysis II	50	02
MTH 3106	Mechanics I	50	02
MTH 3107	Linear Algebra II	50	02
		Total Credits	18

3rd Year 2nd Semester

Course Code	Course Title	Marks	Credits
MTH 3201	Abstract Algebra II	100	03
MTH 3202	Real Analysis II	100	03
MTH 3203	Differential Geometry	100	03
MTH 3204	Mechanics II	50	02
MTH 3205	Methods of Applied Mathematics I	100	03
MTHL 3206	FORTRAN Programming Lab II	50	02
MTHV 3207	Viva-Voce	50	02
		Total Credits	18

4th Year 1st Semester

Course Code	Course Title	Marks	Credits
MTH 4101	Theory of Numbers	100	03
MTH 4102	Topology	100	03
MTH 4103	Methods of Applied Mathematics II	100	03
MTH 4104	Partial Differential Equations	100	03
MTH 4105	Linear Programming	100	03
MTH 4106	Hydrodynamics	100	03
MTH 4107*	Discrete Mathematics	100	03
MTH 4108*	Financial Mathematics	100	03
		Total Credits	21

*** One of the courses from MTH 4107 to MTH 4108 will be offered by the Academic Committee.**

4th Year 2nd Semester

Course Code	Course Title	Marks	Credits
MTH 4201	Functional Analysis	100	03
MTH 4202	Tensor Analysis	100	03
MTH 4203*	Astronomy	100	03
MTH 4204*	Fuzzy Mathematics	100	03
MTH 4205*	Mathematical Modeling in Biology	100	03
MTH 4206*	Actuarial Mathematics	100	03
MTH 4207*	History of Mathematics	100	03
MTH 4208*	Graph Theory	100	03
MTH 4209*	Mathematical Hydrology	100	03
MTHP 4210	Honors Project	100	03
MTHL 4211	MATLAB	100	03
MTHV 4212	Viva-Voce	50	02
		Total Credits	20

*** Two of the courses from MTH 4203 to MTH 4209 will be offered by the Academic Committee.**

MTH 1101: Fundamentals of Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 1101	Fundamentals of Mathematics	Theory	2	35	10	5	15	50

Course Description: Fundamentals of Mathematics is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. This is a work-text that covers the traditional study in a modern pre-algebra course, as well as the topics of estimation, elementary analytic geometry, and introductory algebra. This course aims to provide learning of fundamental concepts of mathematics which are essential for mathematical thinking. The course includes concepts and theories such as elementary set theory, graph and relation, logic, Real number systems, inequalities.

Rationale: Fundamentals of Mathematics is a foundation course of mathematics. Without understanding this course no one can proceed to learn other areas of mathematics. After completion of this course, students will get some useful and applicable ideas on mathematical logic, Set Theory, Functions and Inequalities.

Course Objectives: This course is to prepare students to be able to gather knowledge on some basic mathematics. It helps to know the use of logic, set theory, relations and functions and to learn about the real number systems including their properties and basic inequalities. It also develops knowledge on some basic mathematics like, Algebra and Trigonometry, the course is very productive.

Course Learning Outcomes (CLOs):

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

CLO1: identify mathematical statements, Logic and truth table and their applications;

CLO2: use the set theory in the real world and make a comparison between sets and De Moivre's theorem to solve several equations;

CLO3: understand set theory in detail and apply this concept to solve real-world problems;

CLO4: understand mathematical concepts and definitions of various functions and relations;

CLO5: analyze natural numbers, integers, rational, irrational numbers and inequalities;

CLO6: understand number systems, sequences, series and inequalities;

CLO7: apply the knowledge of this course to solve problems in the real world.

Course Content	CLOs	Hrs
Elements of Logic: Mathematical statements, Logical connectives, Conditional and bi-conditional statements, Truth tables and tautologies, Quantification, Logical implication and equivalence, Deductive reasoning.	CLO1	6 Hrs
Sets and Subsets: Set operations, Family of sets, Cardinality of sets, De Morgan's laws, Applications of set theory.	CLO2 CLO3	5 Hrs
Relations and Functions: Cartesian product of sets, Relations, Order relation, Equivalence of sets, Equivalence relations, Injective, Surjective and Bijective functions, Inverse functions, Images and inverse images of sets.	CLO4	8 Hrs
The Real Number System: Field and order properties, Natural numbers, integers and rational numbers and irrational numbers Absolute value, Basic inequalities, inequalities involving means, powers inequalities of Weierstrass, Cauchy, Chebyshev, Holder.	CLO5 CLO6 CLO7	11 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Theory and problems on set theory and related topics – Schaum's Outline Series
2. Higher Algebra – Barnard & J. M. Child.
3. Naive Set Theory – P.R. Halmos

Reference Books:

1. Higher Algebra – Prof. Md. Abdur Rahman.
2. Algebra – W. I. Ferrar.
3. Fundamentals of Mathematics – Dewan Kuddus, Sawkat Hossain & Md. Mizanur Rahman.

MTH 1102: Calculus I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 1102	Calculus I	Theory	3	70	20	10	30	100

Course Description: Calculus I is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Calculus provides a way of viewing and analyzing the physical world. Calculus is an exciting subject, justly considered to be one of the greatest achievements of the human intellect. As with all mathematics courses, calculus involves equations and formulas. The concept of the rate of change of one quantity with respect to another quantity and finding the area are the fundamental problems in the branch of mathematics which is studied in the name of Calculus. Newton and Leibniz had found a fundamental relationship between the problem of finding a tangent line to a curve and the problem of determining the area of a region in the seventeenth century. Calculus is divided into two main streams, one is Differential calculus and the other is Integral calculus. Generally, the part of calculus concerned with finding tangent lines and rates of change is called differential calculus and that part concerned with finding areas is called integral calculus.

Course Objectives:
The course aims to provide a firm foundation in the concepts and techniques of calculus, including basic functions and graphs and their properties, curve sketching, limits, continuity, differentiation, successive differentiation, relative extrema and applications, Rolles and Mean-value theorem. In this course, the student will be able to find the rate at which one quantity changes relative to another.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: state various elementary functions both algebraically and graphically;
CLO2: explain the graph of the equation which follow function or inverse function;
CLO3: Achieves curve sketching techniques;
CLO4: impart the basic concept of limit, continuity;
CLO5: identify the end behavior of a function and continuity of various types of functions;
CLO6: illustrate the application of differentiation in real-world problems;
CLO7: develop techniques of derivatives and apply them in determining maxima, minima, tangents, normals.

Course Content	CLOs	Hrs
Functions and their Graphs: Polynomials and rational functions, logarithmic and exponential functions, trigonometric functions and their inverses, hyperbolic functions and their inverses, combinations of such functions	CLO1 CLO2 CLO3	11 Hrs
Limit and Continuity: Definitions and basic theorems on limit and continuity, Properties of continuous function, Limit at infinity and infinite limits and computation, L'Hôpital's Rules, Intermediate value theorem with applications.	CLO4 CLO5	10 Hrs
Differentiation: Tangent lines and rates of change, Definition of derivative. One-sided derivatives. Rules of differentiation (proofs and applications). Chain rule theorem. Successive differentiation. Leibnitz theorem (proof and application). Related rates. Linear approximations and differentials.	CLO6 CLO7	12 Hrs
Applications of Derivatives: Rolle's theorem, Mean value theorem, Intermediate value theorem for derivation and its applications, Concavity and points of inflection. Maximum and minimum values of functions, Absolute maximum and minimum values of functions, Optimization problems.	CLO6 CLO7	12 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Calculus – Howard Anton, IrlBivens and Stephen Davis, 10th Edition, John Wiley&Sons, Inc.
2. Calculus – Robert T. Smith and Roland B. Minton, 4th Edition, Mc Graw Hill.

Reference Books:

1. Calculus – D. G. Zill and W. S. Wright, 4thEdition, Jones and Bartlett Publications
2. Calculus – J. Stewart, 8th Edition, Cengage Learning.
3. Differential Calculus – Das and Mukherjee.

MTH 1103: Two Dimensional Geometry

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Perfor mance	Sub-total	
MTH 1103	Two Dimen-sional Geometry	Theory	2	35	10	5	15	50

Course Description:
Two-Dimensional Geometry is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale:
Geometry combines numbers and shapes. In algebra, we have 1st, 2^{nd} and higher-order equations which have geometrical shapes. Geometrical problems can be solved by algebra and algebraic problems can be solved by geometry. So, geometrical conception is essential for mathematics students. This course naturally finds applications in all fields of mathematics, engineering and physical sciences as well.

Course Objectives:
The Two-Dimensional Geometry course includes an in-depth analysis of plane and coordinate geometry. In this course, students will deepen their understanding of geometric relationships in a plane in space and deductive proof in both mathematical and non-mathematical situations. Students will learn about points, lines, circles, parabolas, ellipses, hyperbolas, conics and their various features. Students will study axioms of geometric methods and gain the ability to prove concepts by using the techniques of axiomatic geometry

Course Learning Outcomes (CLOs):
After successful completion of this course, students will be able to:

CLO1: translate and rotate a rectangular coordinate system;
CLO2: draw points, lines, midpoints, distances, and vectors in two-dimensional space;
CLO3: identify pair of straight lines, comics and circles from a general equation of second degree;
CLO4: sketch graphs and discuss relevant features of lines, circles and conic sections;
CLO5: identify Parabola, Ellipse, Hyperbola and their properties;
CLO6: analyze a system of circles and their properties.

Course Content	CLOs	Hrs
Co-ordinates: Transformation of Cartesian coordinates and polar coordinates.	CLO1	6 Hrs
Pair of straight lines: Homogeneous second-degree equations, General second-degree equations representing pair of straight lines, the angle between pair of straight lines, bisectors of angles between pair of straight lines applications.	CLO2 CLO3	8 Hrs
General equations of the second degree: Conic Sections; Reduction to standard forms, identifications, properties and tracing of conics. Polar equation of conic with applications, Detail Study on Ellipse, Parabola, Hyperbola.	CLO4 CLO5	10 Hrs
System of circles: System of circles and its properties.	CLO6	6 Hrs

Evaluation:
70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:
1. Calculus 9/E – Howard Anton.
2. Analytic Geometry and Vector Analysis – A. F. M. Abdur Rahman & P.K. Bhattacharjee.

Reference Books:
1. Analytic Geometry – J.M. Kar.
2. Analytic Geometry and Vector Analysis – Khosh Mohammad.
3. Analytic Geometry – S. Loney.

MTHR 1104: Fundamental English

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 1104	Fundamental English	Theory	3	70	20	10	30	100

Course Description: Fundamental English is a compulsory course for the students of the B.Sc. (Honors) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact between the students and the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Apart from this, the listening-speaking portion will be conducted through practical activities like playing both audio and video clips in the class, showing pictures for describing, showing movies and holding debates, etc.

Rationale: Fundamental English provides the students with significant skills necessary for both academic and everyday use of the international language English. It also helps them prepare for higher education at home and abroad. The immense practical application of the course enables the students to express themselves in both verbal and written English to present themselves in academic and professional interviews.

Course Objectives: The primary objective of this course is to make students competent in all the four communication skills of the English language: reading, writing, listening and speaking. Additionally, the grammar portion in the course is designed to enhance the students' knowledge of the form, meaning and use of English word and sentence structures. They will be able to identify and analyze the functions of grammatical categories in English such as parts of speech and sentence elements, different sentence structures and clause combinations. The reading strategies used in the course will help the students to interrelate with various kinds of texts and interpret their meanings. The writing techniques and strategies used in the course will help the students to compose their thoughts, react to issues, and teach them the boundaries and boundlessness of the writing process. The course is also designed to make students efficient in speaking, giving them the ability to make public speeches and formal presentations, and providing them with critical listening skills.

Course Learning Outcomes (CLOs)

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

CLO1: read and listen to authentic texts, replicate the texts input;
CLO2: write with minimal linguistic flaws, critical reading and writing, improve vocabulary;
CLO3: develop note-taking and non-verbal communication skills;
CLO4: understand organization and cohesiveness of a text;
CLO5: grow the ability to make public speeches and formal presentations, improve critical listening skills;
CLO6: respond to directed questions, demonstrate proper public speaking decorum;

CLO7: build an understanding of sentence structures and identify functions of different grammatical elements, develop grammatical proficiency in writing activities;
CLO8: build effective communication between people around the world, work as a courier for transmission of knowledge.

Course Content	CLOs	Hrs
1. Reading Skill: (a) The idea of readability and effective reading (b) Practicing Comprehension	CLO1 CLO4	6 Hrs
2. Grammar	CLO7	10 Hrs
3. Writing Skill: (a) Definition Topic sentence & Thesis proposition, Principles and types of paragraph writing (b) Writing composition & various types of composition (c) Basics of communication (Letter- Public & Business) and Report writing	CLO2 CLO3	10 Hrs
4. Speaking Skill: Basics of developing speaking skill	CLO5 CLO6	10 Hrs
5. Listening Skill: Basics of developing listening skill	CLO5 CLO6	5 Hrs
6. Translation: Process of translation, various views on translation from English to Bengali & Bengali to English.	CLO8	4 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. The Real English Grammar. Hester Lott. Vina Publisher.
2. English Skills, John Langan. Longman.
3. Learning English the Easy Way- Dr. Sadruddin Ahmed.
4. A Practical English Grammar- A. J. Thomson and A. V. Martinet.

Reference Books:

1. Intermediate English Grammar- Murphy, R.
2. Guide to Patterns and Usage of English- A. S Hornby.
3. Practical writing guide- Barnet Stubbs.
4. Oxford Advanced Learner's Dictionary- A. S Hornby.
5. From Paragraph to Essay- Imhoof, M.
6. Cambridge Advanced Learners Dictionary (With CD-Rom) 3rd Edition.

MTHR 1105: Mechanics and Properties of Matter

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam (2 hours)	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 1105	Mechanics and Properties of Matter	Theory	2	35	10	5	15	50

Course Description: Mechanics and Properties of Matters a compulsory related course for the students of the B.Sc. (Honours program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Students should be considered the prerequisite of taking this course that is the basic understanding of Calculus.

Rationale: This is an introductory physics course that is designed to provide experiences for the student that will lead him/her into an understanding of the basics of physics and nature, which will include some basic integration, differentiation, and discussion of the use of differential equations. Mechanics and Properties of Matter continue the long tradition of practical mathematical calculations. This course naturally finds applications in all fields of applied Physics, mathematics, engineering and physical sciences as well.

Course Objectives: It can be considered as a preparatory course on Physics. To understand the basic concept of materials Properties. To correlate materials properties to identify the strengthening mechanisms. Understand the basics of vectors. Analyze and design various motions such as linear motion, circular motion, rotational motion and gravitational motion. Understand the elasticity, surface tension and fluid dynamics. How to set up the problems correctly in terms of equations. The reasons behind the use of differential equations for expressing the laws of Physics. How the existence of derivatives at every space-time point confirms that the system is changing continuously. Work with students to an understanding of core mathematical and scientific concepts, supporting student learning at all skill levels in foundational science and mathematics. Partner with faculty, student support organizations, and others to raise awareness of the importance of mathematics in developing critical thinking skills across the curriculum. Advance the scientific method and mathematical reasoning as tools for problem solving and engagement with the research process. Prepare student employees to bring mathematical and scientific reasoning skills to their academic and professional careers. Put a high priority on student learning in a personal environment. Encourage students to participate in the learning experience through participation in the classroom, involvement in faculty-directed student research, student-oriented seminars, and other related activities. Produce dynamic and interactive leadership for the discipline. Inspire both faculty and staff members of the discipline to improve professional development opportunities as well as fundamental research in pure and applied mathematics and mathematical knowledge that make educational excellence possible. To predict the elastic response of a simple component given a knowledge of the geometry and mode of loading. To apply one or more equations describing the performance of the components determining the material properties that govern the performance of the components. Describe the theory of surface tension and its influence in practical applications. Develop the concept of fluid properties during the following in a pipeline. Develop the concept of the theory of fluid dynamics and introduce their applications in practical life.

Course Learning Outcomes (CLOs)

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

- CLO1: know basic knowledge and theoretical methods of solving problems given in mathematical science;
- CLO2: gain an important concept about the basic terms of scalar product and vector Product, can know the physical significance of scalar product and vector product and calculate different types of mathematical problems;
- CLO3: know the physical significance of scalar triple product and vector triple product;
- CLO4: can able to know the velocity, acceleration, ordinary derivatives of vectors, partial derivatives of vectors and unit tangent vector;
- CLO5: know some properties of Gradient, Curl and divergence. to know the physical significance of Gradient, Curl and divergence;

CLO6: analyze and explain the rotational motion and simple harmonic motion, to explain the components linear and some relations between kinematics for a particle in a linear and circular motion;

CLO7: understand the core concepts of stress and strain, Hook's law, Elastic constants and their interrelations, Internal elastic potential energy, Experimental determination of elastic constants, to explain modulus of elasticity or elastic constant from Hooke's law.

CLO8: know about the significance of the gravitational field and potential and understand that if a body is thrown vertically upwards with a minimum velocity of 11.2 $kms^{1,}$ then it will go to space overcoming earth's attraction understand the surface tension;

CLO9: to explain ideal fluid, elastic bodies from Newton's law of viscosity;

CLO10: describe a broad knowledge about concepts of fluid, equation of continuity, measurement of viscosity and identify the fluid characteristics;

CLO11: learn about the basic idea and real-life examples of fluid dynamics. To get concepts of the significance of Reynold's number;

CLO12: know the real-life applications of streamline flow and turbulent flow;

CLO13: understand Bernoulli's equation and Poiseuille's formula and apply them in the field of practical applications.

Course Content	CLOs	Hrs
Vector Analysis: Scalar product, Vector product, Triple vector products, Derivatives of vectors; Gradient, Curl and Divergence: physical significance and applications.	CLO1, CLO2 CLO3, CLO4 CLO5	6 Hrs
Rotational Kinematics: Rotational motion; Rotation with constant angular acceleration; Rotational quantities as a vector, Relations between kinematics for a particle in linear and circular motion (vector form).	CLO1 CLO6	4 Hrs
Elasticity: Hookes law, classification of modulus of elasticity; Poisson's ratio; Relation between elastic constants.	CLO1 CLO7	7 Hrs
Gravitation: Newton's law; Gravitational field and potential and their calculation in simple cases; Escape velocity; Compound and Kater's pendulum.	CLO1 CLO8	5 Hrs
Fluid Dynamics: Streamline flow; Turbulent flow; Poiseuilli's equation, Reynold's Number; Bernoulli's theorems and its applications.	CLO1, CLO9 CLO10, CLO11 CLO12, CLO13	8 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Vector Analysis – Spiegel, M.
2. Mechanics and Properties of Matter – Brijlal.
3. Physics – Resnick, R.and Halliday, D.

Reference Books:

1. Physics – Resnick, R. And Halliday, D. & Krane, K.
2. General Properties of Matter – Newman F. W. and Searle VHL.

MTHR 1106: Introduction to Computer Application

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 1106	Introduction to Computer Application	Theory	2	35	10	5	15	50

Course Description: Introduction to Computer Application is a compulsory course for the students of the B.Sc. (Honours) program in Mathematics. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: The course 'Introduction to Computer Application' is designed to provide a continued study of current computer terminology and technology and advanced skill development in computer hardware, software applications and procedures.

Course Objectives: This course can be considered as a fundamental course for students of any discipline as they need to be competent in some basic computer applications for their whole student life and thereafter. The main objective of this course is to provide a general understanding of how a computer works, briefly introduce them to the basic components of a computer and finally give an introductory practical concept of different application software packages.

Course Learning Outcomes (CLOs)

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

CLO1: know about the history of computers and their different generations.;
CLO2: know about the basic knowledge of the different components of a computer and its working mechanism;
CLO3: know about computer database and their application;
CLO4: use different operating systems;
CLO5: write basic programs on different programming languages;
CLO6: know computer applications to produce desired output and build word processors to generate technical reports according to given format specifications;
CLO7: use spread sheet to produce different types of analytical and graphical reports;
CLO8: know about the basic idea of networking and use different networks protocols.

Course Content	CLOs	Hrs
Computer Basics: History, Computer Generation, Classification of computer-based on configuration, operation and capacity, characteristics of a computer, Impact of computers on society and technology. Number system.	CLO1 CLO2	3 Hrs
Specification of Computers: CPU types, Speed variation, Memory, type size Cache, Storage Media, Hard disk. Floppy disk, CD ROM, DVD. Printer: Dot Matrix Printer/ Laser Printer, Inkjet	CLO1 CLO2	4 Hrs

Printer. Computer Hardware: Digital electronics, CPU. Memory: RAM, ROM, DRAM, SRAM, PROM, EPROM, EFROM, Mass storage devices.		
Number System of Computers: Binary, decimal, Octal, Hexadecimal number format, conversion from one number system to another.	CLO2	3 Hrs
Computer Arithmetic and Logic: Binary Addition, Binary subtraction, Binary Multiplication and Division. Boolean logic, Basic logic gate: AND, OR, NOT XOR gate, universal gate: NOR, NAND gate, minimization of Boolean algebra k-map minimization.	CLO2	3 Hrs
Computer Database: Introduction to the database, application of database, difference between file system and database, database software, Idea of the database: table, Row, Primary key, tuple, SQL. I/O Devices:	CLO3	3 Hrs
The idea of System Software and Application Software: Function of Operating System, Discussion on different types of Operating Systems: DOS/Window, Mac UNIX/LINUX, etc.	CLO4	3 Hrs
Concept of formal Languages: Different types of Computer Languages, Assembly, FORTRAN, Pascal C and C++, Artificial Language, etc.	CLO5	4 Hrs
Purpose and Scope of Application Packages: Essential General purpose packages, Word Processing, Spreadsheet analysis, database latex, etc.	CLO6 CLO7	4 Hrs
Networking: Different types of networks, network topologies, communication media. Internet through Virtual reality may be reduced, E-mail, E-commerce, IP address.	CLO8	3 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Introduction to Computers – Peter Norton
2. Fundamentals of Computer – P.K. Sinha

Reference Books:

1. Fundamentals of Computers – E. Balagurusamy.
2. Computer Fundamentals – Dr. Lutfur Rahman.
3. Computer Fundamentals – Goel.

MTHR 1107: Introduction to Computer Application Lab

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHR 1107	Introduction to Computer Application Lab	Practical	2	35	5	5	5	15	50

Course Description: Introduction to Computer Application Lab is a compulsory lab. course for the students of the B.Sc. (Honours) program which is conducted in the laboratory. This lab course carries 2 credits and 30 hours of teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in the computer lab which includes fundamental concepts of computers and some basic applications of computer programs. Tests/quizzes/assignments are taken over lecture materials performance using computers.

Rationale: Introduction to Computer Application lab is based on basic computer knowledge. A computer laboratory is important in every university to enhance the scientific and technological research and invention capacity of students. It means a good and practical computer lab that makes students interesting and enthusiastic about technology and science. This course provides a comprehensive introduction to Microsoft Office (word, excel, power point). Learning Bangla typing is significant since Bengali is our mother language. Learning Mathematical equation typing is essential for every student of Mathematics. In addition, since this is an era of technology as well as the internet, basic to high-level knowledge of using the internet play a vital role in students' undergraduate and graduate level as well as the job market.

Course Objectives:

This course “Introduction to Computer Application lab” is designed to develop basic computer skills in students coming from higher secondary level. It aims to provide students with an understanding of the role of windows computer operating systems. To give the basic knowledge of Microsoft office for which students can learn how to work using documents, excel and PowerPoint. Provide ideas about Bangla typing with Bijoy and Avro font. Provide ideas about typing mathematical equations using math type equation editor. Provide basic knowledge of using the Internet for which students can use the internet search engine, email, google drive, drop box, google class room, google meet, zoom; and can upload documents, download and install the software. It also aims to help students, regardless of their major, to feel justifiably confident of their ability to use computer systems to accomplish their goals.

Course Learning Outcomes (CLOs):

After the completion of the course, students will be able to:

CLO1: start and exit a Windows application and use computers with all the basic understanding of computer system;

CLO2: practical use of MS office with format text and documents including the ability to use automatic formatting tools and insert, edit, and format tables in a document;

CLO3: modify worksheet data and structure and format data in a worksheet and also sort data, manipulate data using formulas and functions and add & modify charts in a worksheet;
CLO4: create and format simple power point presentations;
CLO5: write anything using Bijoy and Avro Bangla font;
CLO6: type mathematical equation using Math Type equation editor;
CLO7: use the internet for email, google drive, google class room, google meet, zoom, etc. and download & install different software.

Course Content	CLOs	Hrs
Operating Systems: Windows: Students will learn the basics of computers, how to operate them in two basic environments, Dos and Windows.	CLO1	06 Hrs
Word Processor: Students will learn to use a popular word processor to create a camera-ready test file complete with figures, columns and tables, **Spread Sheet:** Students will learn to use a popular Spread Sheet to maintain a small database, minor book keeping and statistical and graphical analysis of data. **Presentation package:** Students will learn how to create multimedia slides and animation.	CLO1 CLO2 CLO3 CLO4	10 Hrs
Bangla Typing: As a mother language students will learn how to write anything using Bijoy and Avro Bangla font.	CLO4 CLO7	04 Hrs
Mathematical Equation Typing: Students will learn how to write any mathematical equation using Math Type Equation Editor.	CLO5 CLO7	04 Hrs
Internet: Student will learn how to use a search engine, web browser, mail basic, upload and download concepts, internet download manager (IDM) installation, Google drive, Google class room, Dropbox, LAN connection, broadband connection, internet connection through a modem, switch, hub, router introduction, basic of an internet interface card, enable or disable of internet connection, IP address concept.	CLO1 CLO7	06 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 5 marks and another 5 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 5 marks. Therefore, continuous assessment for lab consists of one midterm (5 marks), lab performance (5 marks) and assignments (5 marks). In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Introduction to Computers – Peter Norton
2. Computer Fundamentals – Dr. Lutfur Rahman

Reference Books:

1. Fundamentals of Computer – P. K. Sinha

MTH 1201: Basic Algebra

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 1201	Basic Algebra	Theory	2	35	10	5	15	50

Course Description: Basic Algebra is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Basic Algebra is the foundation of mathematics. Without understanding these subjects no one can proceed to learn mathematics. After completion of this course, students will get some useful and applicable ideas on mathematical logic, Complex numbers, Theory of equations, Algebraic series, Matrices and determinants.

Course Objectives:

The aim of the course is to provide knowledge on some basic mathematics, the course is very productive. Students will get the actual idea of real and complex number systems. Students will learn about algebraic and trigonometric series, matrices and determinants and most importantly and very useful theory of equations.

Course Learning Outcomes (CLOs)

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

CLO1: perform basic mathematical operations with complex numbers; Find complex solutions of certain equations;
CLO2: use De Moivre's theorem to solve several equations;
CLO3: write the synthetic division rule to find the result of the division of a polynomial by a linear factor;
CLO4: illustrate algebraic, trigonometric series;
CLO5: explain the theory of mathematical induction;
CLO6: understand the concept of a matrix to solve systems of linear and non-linear equations and inequalities;
CLO7: using techniques of graphing, Cramer's rule, determinants, matrices;
CLO8: determine and apply the reduced (row) Echelon form of a matrix;
CLO9: to be able to get knowledge of matrix application problems, Leontief input-output models.

Course Content	CLOs	Hrs
1. **Complex Number System:** Field of Complex numbers, De Moivre's theorem and its applications.	CLO1 CLO2	6 Hrs
2. Theory of equations: Relations between roots and coefficients, Symmetric functions of roots, Sum of the powers of roots, Synthetic division, Des Cartes' rule of signs, Multiplicity of roots, Transformation of equations	CLO3	6 Hrs
3. Summation of series: Summation of algebraic and trigonometric series.	CLO4 CLO5	4 Hrs
4. Matrices and Determinants: Algebra of matrices, Determinant function and its properties, Elementary row (or column) operations and row reduced echelon matrix, Invertible matrices and their inverses, Block matrices, Different types of matrices.	CLO6 CLO7 CLO8	8 Hrs
5. Leontief Model: Input-output analysis.	CLO9	6 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Theory and problems on set theory and related topics – Schaum's Outline Series
2. Higher Algebra – Bernard and Child.

Reference Books:

1. Higher Algebra – Prof. Md. Abdur Rahman.
2. Higher Algebra – W. I. Ferrar.

MTH 1202: Calculus II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 1202	Calculus II	Theory	3	70	20	10	30	100

Course Description: Calculus II is a compulsory course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course (Calculus II) is associated with integral calculus. Integral calculus is a branch of calculus concerned with the theory and applications of integration. Integral calculus deals with total size or values, such as lengths, areas and volumes. This course is important for understanding a wide range of real-world problems, including a range of contexts in physics and engineering and is also significant when studying mathematics (e. g. real and complex analysis). The great utility of this subject emanates from its use in solving differential equations.

Course Objectives:

The course aims to provide a firm foundation in the concepts and techniques of integrations.
It is primarily concerned with developing the students' understanding of the concepts of antiderivatives and providing experience with its methods and applications. It is to emphasize a multi-representational approach to integral calculus, with concepts, results, and problems being expressed geometrically, numerically, analytically, and verbally. In addition, to acquire the knowledge of applying these representations in finding the length of a plane curve, an area under a curve, an area between two curves, volumes, area of the surface of revolution. Finally, the overall goal is to grow interested and provide the kind of problem-solving experience that the students might find in a research or industrial setting.

Course Learning Outcomes (CLOs)

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

CLO1: understand the concepts of antiderivatives and indefinite integrals, learn different techniques of evaluating integration;
CLO2: realize the meaning of the definite integral both as a limit of Riemann sums and as the area under a curve;
CLO3: learn to understand differentiation and anti-differentiation as inverse operation;
CLO4: learn basic properties of integration, evaluation of integration by successive reduction;
CLO5: develop and apply definite integrals to evaluate area between two curves, volumes of solids of revolution, surface area, arc lengths utilizing different methods;
CLO6: draw diagrams in polar coordinates, find tangent curves, evaluate areas enclosed by polar curves and arc lengths of the curves;
CLO7: test convergence and divergence of different series, understand the different types of improper integrals and solve them;
CLO8: evaluate some special integrals applying gamma and beta functions;
CLO9: approximate different series and to evaluate differentiation and integration series;
CLO10: apply the method of integration to real-life problems.

Course Content	CLOs	Hrs
Integration: Anti-derivatives and indefinite integrals, Techniques of integration, Definite integration using anti-derivatives, Definite integration using Riemann sums, Fundamental theorems of calculus (proofs and applications), Basic properties of integration. Integration by reduction.	CLO1 CLO2 CLO3 CLO4	14 Hrs
Applications of integration: Plane areas, Volumes of solids of revolution. Volumes by cylindrical shells, Volumes by cross-sections. Arc-length, Area of a surface of revolution.	CLO5	6 Hrs
Graphing in Polar Coordinates and Applications: Curve tracing, Tangents to polar curves, Areas enclosed by curves in polar coordinates, Arc length, area and volume of the surface of revolution in polar co-ordinates.	CLO6	12 Hrs
Improper integrals: Tests of convergence and their applications. Gamma and Beta functions with applications.	CLO7 CLO8	10 Hrs
Approximations and Series: Taylor polynomials and series, Convergence of series, Taylor's series, Taylor's theorem with remainders, Differentiation and integration of series. Validity of regions of Taylor series and computations with series. Applications to Business, Economics, Social Sciences, Biological and Physical & Engineering sciences.	CLO9 CLO10	3 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Calculus 10/E – Howard Anton.
2. Integral Calculus – Das &Mukharjee, U.N. Dhur& Sons Private Ltd. Revised Edition.
3. Schaum's Outline Series – Frank Ayres, Elliott Mendelson.

Reference Books:

1. Calculus – E.W. Swokowski.
2. Differential Calculus – Das &Mukharjee, U.N. Dhur& Sons Private Ltd. 22nd Edition.
3. Calculus – Tom M. Apostol, Vol. 1 (2nd Edition), 1991.
4. Calculus – James Stewart, Thomson learning, INC 2005.
5. Calculus with Analytic Geometry- Thomas & Finney

MTH 1203: Three-Dimensional and Vector Geometry

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 1203	Three-Dimensional and Vector Geometry	Theory	2	35	10	5	15	50

Course Description: Three-Dimensional and Vector Geometry is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Three-dimensional geometry is originally developed to model the physical world. Geometry combines numbers and shapes. In algebra, we have 1st, 2nd and higher-order equations which have geometrical shapes. Geometrical problems can be solved by algebra and algebraic problems can be solved by geometry. Furthermore, vectors provide an elegant approach to studying straight lines and planes in three dimensions. So, three-dimensional and vector geometrical conception is essential for mathematics students. This course includes an in-depth analysis of plane, solid and coordinate geometry as they relate to both abstract mathematical concepts as well as real-world problems. It has applications in almost all sciences, and also in art, architecture, and other subjects that are related to graphics.

Course Objectives:
The course aims to provide a firm foundation in the concepts and techniques of three-dimensional and vector geometry. It is primarily concerned with developing the students' understanding of the topic includes a three-dimensional coordinate system, different conicoids with their shapes and figure. Emphasis will be placed on developing critical thinking skills as they relate to logical reasoning and understanding geometric relationships in a plane in space. The overall goal of this course is that the students can incorporate geometry with algebra and vector algebra.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: obtain a properly concluded explanation of the three-dimensional aspects of the geometry;
CLO2: distinguish rectangular, cylindrical and spherical co-ordinates and their translation and rotation;
CLO3: compute the distance between points, the distance from a point to a line, and the distance from a point to a plane, shortest distance, direction cosines and direction ratios in the three-dimensional coordinate system;
CLO4: describe plane and relation between planes and calculate the distance from a point to a plane;
CLO5: sketch sphere and describe general equation of sphere and related topics;
CLO6: identify conicoid. sketch and describe cone, cylinder, paraboloid, ellipsoid, hyperboloid and their properties and uses;
CLO7: identify central and non-central conicoid and their plane section and their pole and polar;
CLO8: sketch and describe regions in space and perform algebraic operations with vectors in two and three dimensions computing dot and cross product of vectors, finding scalar and vector projections of a vector onto another, determining if vectors are parallel and orthogonal, etc.;

CLO9: describe vector equations of lines and planes and compute areas and volumes using vector product.

Course Content	CLOs	Hrs
Co-ordinates: Three-dimensional co-ordinates, Distance, Direction cosines and direction ratios, Projection of line segment, Distance of a point from lines, Angle between two lines with given direction cosines and ratios.	CLO1 CLO2 CLO3	8 Hrs
Planes: Equation of a plane, the angle between two planes, the distance of a point from a plane.	CLO4	6 Hrs
Straight lines: Equations of lines, the relationship between planes and lines, shortest distance.	CLO2	3 Hrs
Spheres: General equation of a sphere, Plane section of a sphere, Khalifa's method, condition of orthogonality, Radical plane, Radical line, Radical center.	CLO5	3 Hrs
Conicoids: Basic properties of conicoids.	CLO6 CLO7	4 Hrs
Vector Geometry: Vectors in plane and space. Algebra of vectors. Rectangular Components. Scalar and Vector product. Scalar triple product and vector triple product.	CLO8	4 Hrs
Applications of vectors in geometry: Vector equations of straight lines and planes, areas and volume.	CLO9	2 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Analytic Geometry of Conic Section – A. H.Askwith
2. Analytic Geometry of Conic Section – J.M.Kar
3. A Treatise on Three Dimensional Geometry – J.T.Bell

Reference Books:

1. A Textbook of Analytical Geometry of Three Dimension – P. K. Jain
2. Vector Geometry – J. A. Hummel.
3. Theory and Problems of Vector Analysis – Murray R. Spigel.
4. Calculus with Analytic Geometry – Thomas & Finney

MTHL 1204: Mathematica Lab I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assign ment	Perform ance	Sub-total	
MTHL 1204	Mathem atica Lab I	Practical	3	70	10	10	10	30	100

Course Description: Mathematica Lab I is a compulsory Lab course for the students of the B.Sc. (Honours) program which is conducted in a lab. This lab course carries 3 credits and 45 hours of teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes in computers. Tests/quizzes/assignments are taken on programming performance using computers. For programming, different problems are solved in concurrent courses (first year) using Mathematica programming languages.

Rationale: *Mathematica* is a mathematical computation program, used in many scientific, engineering, mathematical and computing fields. It was conceived by Stephen Wolfram and is developed by Wolfram Research of Champaign, Illinois. The Wolfram Language is the programming language used in Mathematica. It is applicable for all engineering disciplines and many natural sciences as well. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Course Objectives:
Mathematica is a high-performance language for technical computing. Mathematica allows mathematical skills to be brought to a technical level. With its many built-in functions, Mathematica allows for complex problems to be solved efficiently and accurately. The goal of this course is to introduce students to the fundamental concepts of scientific programming using Mathematica with the necessary mathematical concepts. This course will provide concepts about the syntax and semantics of Mathematica including data types, control structures, comments, variables, functions, equation solving, plotting, differentiation, integration and other abstraction mechanisms.

Course Learning Outcomes (CLOs):
After the completion of the course, students will be able to:

CLO1: acquire knowledge about scientific programming language using Mathematica with the necessary mathematical concepts;
CLO2: review how to use Mathematica as a programming tool and how to write a program for concurrent courses that is well documented and easy to read;
CLO3: create two- and three-dimensional graphs using Mathematica codes;
CLO4: perform integrals, derivatives, and assign values to variables to solve complex equations using Mathematica codes;
CLO5: solve numerical differential and integral equations using Mathematica codes;
CLO6: solve different real-life mathematical and engineering problems using Mathematica codes.

Course Content	CLOs	Hrs
Basic Concepts: Constants, 'Built-in' functions, Basic Arithmetic operations, Strings, Assignment and Replacement, Logical Relations, Sums and Products, Loops, User-Defined Functions, Operations on Functions.	CLO1 CLO2	10 Hrs
Lists: Generating Lists, List Manipulation, Set Theory, Tables and Matrices.	CLO1 CLO2 CLO3 CLO6	5 Hrs
Two- and Three-Dimensional Graphics: Plotting functions of single and two variables, Graphics commands, Special two and three-dimensional plots, Animation.	CLO1 CLO2 CLO3	10 Hrs
Equations: Solving Algebraic and Transcendental equations	CLO1 CLO2 CLO6	5 Hrs
Algebra and Trigonometry: Polynomials, Rational and Algebraic functions, Trigonometric functions.	CLO1 CLO2 CLO6	5 Hrs
Differential and Integral Calculus: Limits, Derivatives, Maximum and Minimum values, Power series, Antiderivatives, Definite integrals, Riemann Sums.	CLO1 CLO2 CLO4 CLO5 CLO6	10 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 10 marks and another 10 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 10 marks. Therefore, continuous assessment for lab consists of one midterm (10 marks), lab performance (10 marks) and assignments (10 marks). In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Mathematica – Schaum's Outline Series (2^{nd} Edition).
2. Mathematica – Wolfram Research (Student edition)

Reference Books:

1. Essentials of Programming in Mathematica – Paul Wellin
2. The Student's Introduction to Mathematica and the Wolfram Language – Bruce F.Torrence, Eve A. Torrence

MTHV 1205: Viva-Voce
50 Marks:02 Credits
Viva Voce on courses taught in the **first and second** semesters (first year).

MTHR 1206: Electricity, Magnetism and Optics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam (2 hours)	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 1206	Electricity, Magnetism and Optics	Theory	2	35	10	5	15	50

Course Description: Electricity, Magnetism and Optics is a compulsory related course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Students should be considered the prerequisite of taking this course that is the basic understanding of Calculus and Vector Analysis.

Rationale: This course is an introduction to electricity, magnetism and Optics and their mathematical description, connecting electric and magnetic phenomena. Topics include electrostatics, magnetic fields, electromagnetic induction, DC and AC circuits, and the electromagnetic properties of matter. This course is an introduction to circuit analysis where students will develop skills in building and debugging electrical circuits. Students have some knowledge of vector calculus as a prerequisite for this course. This course introduces Electrostatics, Magnetostatics, Capacitor, Current, Electromagnetic phenomenon, Gusse's Law, Ampere's Law, Faraday's Law. Understanding and obtaining knowledge of this course bear great importance to innovate and improve the functioning of various types of electric devices and circuits in our daily life. Optics is one of the most important branches of Physics that studies the nature of light, its propagation and its interaction with matter. This branch has nowadays become extremely important because of its widespread applications in diverse areas which in turn led to a silent revolution in communications, medical, biological and many other fields. Optics are divided mainly into two parts: geometrical (or ray) optics and physical (or wave) optics. The content of geometrical optics is designed for giving students a rudimental and comprehensive lesson about the rectilinear propagation of light and its implications. The physical optics is designed for giving a comprehensive model of light that includes wave effects such as coherence, interference, polarization, diffraction.

Course Objectives:
The objectives of the course are as follows: to develop the understanding of fundamental concepts in Electricity and Magnetism more rigorously as needed for application in engineering and technology, to expand the student's thinking process through the understanding of the theory and application of this knowledge to the solution of practical problems, to learn and apply advanced mathematical techniques and methods of use to physicists in solving problems, to introduce ray optics, optical systems containing two or more lenses and to describe the various types of aberrations caused by the lenses and its theory. to introduce the wave theory of light using the principle of superposition, Huygen's wave concept, various experiments to produce interference fringes. to introduce the concept of wave train or wave packet and hence coherent property of light, its classification and many specialized topics relevant with coherence, to understand the phenomenon of diffraction, its classification, theory, the spectral resolution of spectroscopes and many specialized topics relevant with diffraction. to understand the phenomena of polarization and many specialized topics relevant to polarization and to introduce optical communication by optical fiber.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

- CLO1: know basic knowledge and theoretical methods of solving problems given in mathematical science;
- CLO2: understand the fundamental rules and theories in electricity and magnetism;
- CLO3: understand the static and time-dependent properties of electric and magnetic fields and how they arise;
- CLO4: understand important historical experiments in the field of electricity and magnetism;
- CLO5: learn electrical circuits and the most common components such as resistors, capacitors and inductors;

CLO6: analyze different problems in electromagnetism using mathematical methods involving vectors and simple differential and integral calculus;

CLO7: understand the importance of electricity and magnetism in society, especially with regard to technological applications;

CLO8: understand the reasonable physical origin of simple electromagnetic phenomena in nature;

CLO9: know the phenomenon of interference, production of interference based on the division of wave front and division of amplitude, applications of interference, the concept of phase velocity and group velocity. Students will get a detailed account of multiple-beam interference i.e. interference effects in thin films with detailed theory, the working principle and application of different interferometers based on multiple beam interference;

CLO10: understand the concept of coherence, know the role of coherence in determining the condition of inference, Huygens's principle, Interface Young's experiment;

CLO11: understand diffraction phenomena, its classification (Fraunhofer type and Fresnel type), derivation of theories of diffraction of a single slit, double slit and multiple slit. Students will know principles, working and resolving power of diffraction gratings. Further students will be able to calculate the resolving power of the interferometer;

CLO12: understand in detail the polarization, various methods to produce polarized light, Nicol prism, various modes of polarized light and types of the polarizer, optical activity, applications of polarized light.

Course Content	CLOs	Hrs
Electricity and Magnetism: Gauss law, Application of Gauss law, Dielectrics and Gauss law, Ohm's law, Energy transfer in an Electric circuit, Kirchhoff's laws and their applications. Magnetic Induction, Faraday's Law of induction, Motion of a charged particle in a uniform electric and magnetic field. RC, LR and LCR circuits in series and parallel, Resonance, Q-factor, Concept of R.M.S. and an average value of current and voltage.	CLO1 CLO8	15 Hrs
Optics: Fermat's principles, theory of equivalent lenses, Defect of images. Theories of light, Huygens's principle, Interface Young's experiment. Newton's ring, Diffraction, Fresnel and Fraunhofer type, Diffraction through a single slit and double slit. diffraction grating. Introduction of Polarization, Optical Activity, Nicol Prism.	CLO1 CLO9 CLO10 CLO11 CLO12	15 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Electricity and Magnetism with Electronics – K. K. Tewari,
2. Electricity Magnetism and Electronics – B. L. Theraja,

Reference Books:

1. Physics – R. Resnick, D. Halliday, and Krane.
2. Electricity Magnetism and Electronics – Duckworth, H.E
3. Optics – A. Ghatak,
4. Fundamentals of Optics – F.A. Jenkins, and H. A.White,
5. Optics – E. Hecht,
6. A Text book of Optics – N Subrahmanyam, and B Lal.

MTHR 1207: Introduction to Statistics and Probabilities

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 1207	Introduction to Statistics and Probabilities	Theory	3	70	20	10	30	100

Course Description: Introduction to Statistics and Probabilities is a compulsory but related course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. No prerequisite course is necessary to the successful completion of Introduction to Statistics and Probabilities.

Rationale: Basic Statistics is a form of mathematics that allows you to properly collect, analyze, interpret and present data in an easy-to-understand format and concluding information. Putting it in other words, statistics is the methodology that scientists and mathematicians have developed for interpreting and drawing conclusions from collected data. A large number of statistical methods like probability averages, dispersions, estimation, etc., are used in mathematics. The use of modern computers has expedited large-scale statistical computations and has also made possible new methods that are impractical to perform manually. Statistics continues to be an area of active research for example on the problem of how to analyze big data.

Course Objectives:
This course is intended to provide the basic foundations of statistics with applications in real life. The class will cover topics on descriptive statistics, frequency distribution, measures of central tendency, measures of dispersion/variation, shape characteristics of distribution, correlation and regression analysis, probability, and probability distributions for both continuous and discrete random variables. The students will discuss the theory and how to apply and use the theory for real-life problem-solving and inquiry. To develop the students' ability to deal with numerical and quantitative issues in business. To enable the use of statistical, graphical and algebraic techniques wherever relevant. To have a proper understanding of Statistical applications in Economics and a central objective is to provide students with hands-on experience in using the statistical theory and methods to perform the different statistical analyses and to interpret results.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

- CLO1: describe and discuss the key terminology, concepts tools and techniques used in business statistical analysis;
- CLO2: critically evaluate the underlying assumptions of analysis tools;
- CLO3: apply various types of sampling methods to data collection;
- CLO4: create and interpret frequency tables;
- CLO5: display data graphically and interpret graphs: stem plots, histograms, and box plots;
- CLO6: recognize, describe, and calculate the measures of location of data: quartiles and percentiles;
- CLO7: recognize, describe, and calculate the measures of the center of data: mean, median, and mode;
- CLO8: recognize, describe, and calculate the measures of the spread of data: variance, standard deviation, and range;
- CLO9: understand Moments, skewness and kurtosis;
- CLO10: Recognize the simple linear correlation and its properties, rank correlation, simple linear regression model and its fitting by the method of least squares**;**
- CLO11: understand and use the terminology of probability and Bayes' theorem;
- CLO12: recognize and understand continuous probability density functions in general, the uniform probability distribution, the exponential probability distribution;
- CLO13: recognize the normal probability distribution, the standard normal probability distribution, normal probabilities by converting to the standard normal distribution.

Course Content	CLOs	Hrs
1. **Descriptive Statistics:** Nature and scope of statistics, population and sample.	CLO1, CLO2 CLO3, CLO4	2 Hrs
2. **Variables:** Qualitative and quantitative variables, data and collection of data.	CLO3, CLO4 CLO5	2 Hrs
3. **Frequency Distribution:** Frequency distributions for qualitative and quantitative data, graphical representations of data: graphical representations of qualitative data- bar chart and pie chart, graphical representation of quantitative data- histogram, frequency polygon, frequency curve, ogive and stem-and-leaf plot with interpretations.	CLO1 CLO4 CLO5	5 Hrs
4. **Measures of Central Tendency:** Arithmetic mean, geometric mean, harmonic mean, median and mode and their interpretations, quartiles, percentiles and uses.	CLO4, CLO5 CLO6 CLO7	6 Hrs
5. **Measures of Dispersion/variation:** Absolute measures of dispersion range, interquartile range, mean deviation, standard deviation and variance. Relative measures of dispersion– coefficient of variation.	CLO5, CLO6 CLO7 CLO8	10 Hrs
6. **Shape characteristics of distribution:** Moments, skewness and kurtosis, Box and whisker's plot.	CLO5, CLO6 CLO9	5 Hrs
7. **Correlation and regression analysis:** Simple linear correlation and its properties, rank correlation, simple linear regression model and its fitting by the method of least squares.	CLO10	5 Hrs
8. **Probability:** Random experiment, sample space, event, complementary of an event, mutually exclusive and non-mutually exclusive events. The classical, empirical and axiomatic approach of probability. Conditional probability, additive and multiplicative laws of probability. Bayes' theorem. Random variable, probability function and probability density function, joint probability function, marginal and conditional probability functions. Mathematical expectation and its properties, the variance of a random variable and its properties, moment generating function, characteristic function and cumulative generating function, common probability distribution: binomial distribution-definition, derivation, mean and variance, characteristic function and applications. Poisson distribution-definition, derivation, mean and variance, characteristic function and applications. Normal distribution definition and its applications.	CLO11 CLO12 CLO13	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Basic Statistics – Simpson and Kafka, W. W. Norton & Co. Inc. New York, London.
2. An Introduction to Statistics and Probability – M Nurul Islam, Book World, Dhaka.

Reference Books:

1. Introductory Statistics – John Wiley, NY- Hoel P G.
2. Methods of Statistics – Mostofa M G. Bangladesh,
3. Introduction to Probability – Vol-1, 3rd Ed, John Wiley, NY- Fellor W.
4. Probability with Statistical Applications – Mosteller-Rouke- Thomas, Wiley Publishing Company, London.
5. Introduction to Mathematical Statistics – Hogg R V & Craig A T, 4th Ed. McMillan Publishing Co. Inc., London.

MTH 2101: Calculus III

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2101	Calculus III	Theory	2	35	10	5	15	50

Course Description: Calculus is one of the most fundamental courses for the students of the B.Sc. (Honours) program in Mathematics. In our B.Sc. (Honours) program we subdivide this major field into four parts named Calculus I, Calculus II, Calculus III and Calculus IV taught in the first four consecutive semesters of this program. Calculus III mainly focuses on vector functions and multivariable calculus. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course will give an overview of the calculus of vector-valued functions of a single variable, curvature of plane and functions of several variables. It includes multivariate and vector-valued functions from a graphical, numerical, and symbolic perspective.

Course Objectives: This course covers differential, integral and vector calculus for functions of more than one variable. These mathematical tools and methods are used extensively in the physical sciences, engineering, economics and computer graphics. This course aims to give a proper understanding of the basic concepts of vector-valued functions, curvature and the function of several variables. The students will encounter the idea of partial derivatives in this course for the first time. They will also learn several problem-solving strategies and will be able to apply them to real-life problems.

Course Learning Outcomes (CLOs)

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

CLO1: identify vector-valued functions, their limit and integrals;
CLO2: draw and find the tangent lines to the graph of a vector-valued function;
CLO3: determine the arc length of any function from the vector viewpoint;
CLO4: find the arc length parameterization;
CLO5: define curvature and space curve;
CLO6: find the curvature of any intrinsic function, Cartesian equations and parametric equations;
CLO7: calculate the radius of curvature and determine the center of curvature;
CLO8: find the limit and examine the continuity and differentiability of a function of several variables;
CLO9: use chain rule for finding partial derivatives and Determining the directional derivatives;
CLO10: discuss, explain, measure the gradient vectors and tangent planes, extreme values and saddle points of functions of several variables.

Course Content	CLOs	Hrs
Vector-valued functions of a Single Variable: Their limits, derivatives and integrals, Tangent lines to graphs of such functions, Arc length from the vector view point, Arc length parameterization.	CLO1 CLO2 CLO3 CLO4	9 Hrs
The curvature of Plane and Space Curves: Definition, Curvature from the intrinsic equation, Cartesian equations and parametric equations, Radius of curvature, Center of curvature.	CLO5 CLO6 CLO7	10 Hrs
Functions of Several Variables: Limit and continuity, Partial derivatives, Differentiability, Linearization and differentials. The chain rule, Partial derivatives with constrained variables, Directional derivatives, Gradient vectors and tangent planes, Extreme values and saddle points of functions of several variables, Lagrange multipliers, Taylor's formula.	CLO8 CLO9 CLO10	11 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Calculus: Early Transcendentals 10/E – Howard Anton, Irl C. Bivens, Stephen Davis.
2. Calculus With Analytic Geometry – E. W. Swokowski.

Reference Books:

1. Schaum's Outline Series – Frank Ayres, Elliott Mendelson.
2. Calculus: A Rigorous First Course – Daniel J. Velleman.
3. Calculus in Context: Background, Basics, and Applications – Alexander J. Hahn.

MTH 2102: FORTRAN Programming

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2102	FORTRAN Programming	Theory	3	70	20	10	30	100

Course Description: FORTRAN Programming is a compulsory course for the students of the B.Sc. (Hon's) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of MTHR 1106: Introduction to Computer Application.

Rationale: FORTRAN is one of the principal languages used in scientific, numerical and engineering programming and knowledge in FORTRAN is an indispensable qualification for students, researchers, and engineers. With the two recent revisions of the language, the power of the language has been progressively enhanced, and most vendors (IBM, HP, SGI, Intel, Sun, Cray) provide highly optimizing FORTRAN compilers, based on more than 50 years of experience. The course builds to provide a solid foundation of skills to start working with existing codes and to progress to the more advanced course.

Course Objectives:
The main objective of this course is to expose students to algorithmic-problem solving and to develop fundamental skills in FORTRAN programming, with emphasis on a transparent and disciplined programming style, code modularity and reusability of the components.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: explain the basic programming concepts;
CLO2: separate a problem into its logical set of components;
CLO3: interpret and analyze data;
CLO4: describe how good program design reduces the coding and debugging time;
CLO5: study algorithm development for structured programming, designing, coding, debugging, and documenting programs;
CLO6: use this language to solve moderate scientific and engineering computation problems.

Course Content	CLOs	Hrs
Finite Element Method: 1. **Problem-solving techniques using computers:** Flowcharts, Algorithms, Pseudo codes.	CLO1 CLO2	10 Hrs
2. **Programming in FORTRAN:** Syntax and semantics, Data types and structures, Input/output, Loops, Decision statements, Arrays, User-defined functions, Subprograms and recursion.	CLO3 CLO4	15 Hrs
3. **Computing using FORTRAN:** Construction and implementation of FORTRAN programs for solving problems in mathematics and sciences.	CLO5 CLO6	20 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Programming with FORTRAN – Schaum's Outline Series.
2. Fortran 90/95 for Scientists and Engineers – Stephen J. Chapman.
3. Computer Programming in FORTRAN 90 and 95 – V. Rajaraman

Reference Books:

1. Modern Fortran: Building efficient parallel applications – Milan Curcic.
2. Modern Fortran Explained – Michael Metcalf, John Reid, Malcolm Cohen.
3. FORTRAN 90 for Engineers and Scientists – Larry Nyhoff, Sanford Leestma.

MTH 2103: Ordinary Differential Equations I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2103	Ordinary Differential Equations I	Theory	3	70	20	10	30	100

Course Description: Ordinary Differential Equations I is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Calculus I and Calculus II**.**

Rationale: A differential equation is a mathematical equation for an unknown function of one or several variables that relates the values of the function itself and its derivatives of various orders. Real-life problems occur in many areas of engineering, mathematical & physical sciences, and other applied sciences that can be modeled by differential equations. For example oscillation of a simple pendulum representing the equation of motion, bending equation in applied mechanics, chemical reaction equations, moon lander model equation in control and optimization theory, Lotka-Volterra equations in biology, and Stellar structure models in astrophysics, etc.

Course Objectives: The objective of this course is to introduce the basics of ordinary differential equations and terminologies. The students will be able to solve different types of ordinary differential equations analytically using well-known techniques. Exploring the utility of ordinary differential equations in modeling physical & mathematical science and biological systems.

Course Learning Outcomes (CLOs)

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

CLO1: know the basic idea about differential equations, order, degree, classifications, existence and uniqueness theorem;

CLO2: formulate differential equations by removing arbitrary constants from algebraic relations and draw solutions curves using direction field;

CLO3: classify first-order DE's as separable, homogeneous, linear, exact, Bernoulli's, Riccati, Clairaut's equation and solve them using appropriate methods;

CLO4: construct of first-order differential equations as mathematical models and its solutions with physical interpretations;

CLO5: know about higher-order, mostly second order ODE's and their classifications such as homogeneous and nonhomogeneous;

CLO6: solve them using reduction of order, method of undetermined coefficients, variation of parameters, Cauchy Euler equations and their solutions;

CLO7: modeling of second-order differential equations and their solutions with physical interpretations.

Course Content	CLOs	Hrs
1. Ordinary differential equations and their solutions: Classification of differential equations, Solutions, Implicit solutions, Singular solutions, Initial value problems, Boundary value problems, Basic existence and uniqueness (statement and illustration only), Direction fields, Phase line.	CLO1 CLO2	8 Hrs
2. Solution of first-order equations: Variables separable equations, Linear equations, Exact equations, Special integrating factors, Substitutions and transformations, Homogeneous equations, Bernoulli equation, Riccati equation, First-order higher degree equation-solvable for x, y and p. Clairaut's equation, Singular solutions.	CLO3	12 Hrs
3. Modeling with first-order differential equations: Construction of differential equations as mathematical models (exponential growth and decay, heating and cooling, mixture of solutions, series circuit, logistic growth, chemical reaction, falling bodies). Model solutions and interpretation of results. Orthogonal trajectories.	CLO4	8 Hrs
4. Solution of higher-order linear equations: Linear differential equations. The basic theory of linear differential equations, Solution space of homogeneous linear equations, Fundamental solutions of homogeneous equations, Reduction of orders, Homogeneous linear equations with constant coefficients, Method of undetermined coefficients, Variation of parameters, Euler-Cauchy differential equation.	CLO5 CLO6	12 Hrs
5. Modeling with second-order equations: Spring-mass systems, Electrical networks, Rocket motion.	CLO7	5 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Differential Equations – S.L. Ross.
2. Introduction to Differential Equation – Denis Zill.

Reference Books:

1. Ordinary Diff. Equation – F. Braker & J.A. Nohel.
2. An Introduction to Differential Equation and Applications – Martin Braun.
3. Differential Equations and Boundary Value Problems: Computing and Modeling – C. Henry Edwards, David E. Penney and David T. Calvis.
4. Differential equations: A Modeling Perspective – Robert L. Borrelli and Courtney S. Coleman.

MTHL 2104: FORTRAN Programming Lab I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHL 2104	FORTRAN Programming Lab I	Practical	2	35	5	5	5	15	50

Course Description: FORTRAN Programming Lab-I is a compulsory Lab. course for the students of the B.Sc. (Honours) program which is conducted in the lab. In this lab. the course carries 2 credits and 30 hours of teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes in computers. Tests/quizzes/assignments are taken on programming performance using computers. For programming, different problems are solved in concurrent courses (first year) using FORTRAN Programming languages.

Rationale: FORTRAN is a general-purpose, compiled imperative programming language that is especially suited to numeric computation and computing. The name FORTRAN is derived from FORmula TRANslation, indicating that the language was intended from the start for translating scientific equations into computer code. IBM developed the first version of the FORTRAN language. It is applicable for all engineering disciplines and many natural sciences as well. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Course Objectives:
FORTRAN is a high-performance language for technical computing. This course provides an introduction, the structure and contents of the FORTRAN programming language. It will provide the students with enough knowledge to write FORTRAN programs and the students will gain general experience that can usually be applied when using any programming language. The main objective of this course is to expose students to algorithmic-problem solving and to develop fundamental skills in FORTRAN programming, with emphasis on a transparent and disciplined programming style, code modularity and reusability of the components.

Course Learning Outcomes (CLOs):
After the completion of the course, students will be able to:

CLO1: acquire knowledge about scientific programming language using FORTRAN with the necessary mathematical concepts;
CLO2: review how to use FORTRAN as a programming tool and how to write a program for concurrent courses that is well documented and easy to read;
CLO3: confidently design algorithms to solve simple problems and implement algorithms in the processing programming environment;
CLO4: write program code using the iteration structures and conduct pre-tests and post-tests of looping structures;
CLO5: use arrays of one and several dimensions;
CLO6: write efficient program code using FORTRAN's control structures.

CLO7: make proper use of the basic datatypes and the intrinsic operators of the FORTRAN language.
CLO8: solve different real-life mathematical and engineering problems using FORTRAN codes.

Course Content	CLOs	Hrs
Problem-solving techniques using computers: Flowcharts, Algorithms, Pseudo codes.	CLO1 CLO2 CLO3	5 Hrs
Programming in FORTRAN: Syntax and semantics, Data types and structures, Input/output, Loops, Decision statements, Arrays, User-defined functions, Subprograms and recursion.	CLO1 CLO2 CLO4 CLO5 CLO6 CLO7	10 Hrs
Computing using FORTRAN: Construction and implementation of FORTRAN programs for solving problems in mathematics and sciences.	CLO1 CLO2 CLO8	15 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 5 marks and another 5 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 5 marks. Therefore, continuous assessment for lab consists of one midterm (5 marks), lab performance (5 marks) and assignments (5 marks).In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Programming with Fortran – Schaum's Outline Series.
2. FORTRAN: A Structured Disciplined Style – Gordon B. Davis & Thomas R. Hoffmann.
3. Introduction to FORTRAN 90/95 – Stephen J. Chapman

Reference Books:

1. Modern Fortran Explained – Oxford University Press, Michael Metcalf, John Reid, Malcolm Cohen.
2. Computer Programming in Fortran 90 and 95 – V. Rajaraman.

MTHR 2105: Atomic and Nuclear Physics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 2105	Atomic and Nuclear Physics	Theory	2	35	10	5	15	50

Course Description: Atomic and Nuclear Physics is a compulsory related course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: An understanding of the nature of atoms is developed by examining the basic quantum mechanical model for the electronic structure of atoms. Central to this model is the interaction of atoms with light and electric and magnetic fields. Applications that are important for our standards of time and length will be discussed. We then delve further into the atom and examine the structure of the nucleus. The basic concepts and theories of nuclear physics are developed as well as an understanding of the applications of nuclear science.

Course Objectives:
This course will introduce students to the fundamentals of atomic physics and rudimentary nuclear physics. It aims to provide a coherent and concise coverage of traditional atomic and nuclear physics. Important topics of current research interest will be also discussed, such as nuclear reactor and particle physics.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: describe the gross and fine structure of single-electron atoms in light of the semi-classical Bohr and quantum mechanical Schrödinger models;
CLO2: apply the laws of quantum mechanics to multi-electron atoms, taking into account the effects of angular momentum;
CLO3: explain molecular spectra in terms of vibrational, rotational and electronic transitions;
CLO4: describe how the atomic nucleus is structured, reacts and decays;
CLO5: perform analytical calculations associated with the structure of the nucleus;
CLO6: deduce level structures and decay schemes from experimental evidence.

Course Content	CLOs	Hrs
1. Atomic Physics: Planck's radiation formula, Photoelectric effect, Einstein's Photon theory, The Compton effect, The Hydrogen atom and the correspondence principle, Matter waves, Atomic structure, wave mechanics, Uncertainty principle, Atomic excitation.	CLO1 CLO2 CLO3	15 Hrs
2. Nuclear Physics: The nucleus; nuclear force, nuclear radius, mass defect, Binding energy and packing fraction. Radio activity, unstable nuclei, exponential decay law, half-life, mean life, and units of radioactivity, Basic ideas of a nuclear reactor, Nuclear fission and nuclear fusion	CLO4 CLO5 CLO6	15 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Concepts of Modern Physics – A Beiser.
2. Perspectives of Modern Physics – A Beiser.
3. Atomic Physics – J. B. Rajam

Reference Books:

1. Fundamentals of Modern Physics – R. M. Eisberg.
2. Physics of the Atom – Enge, Wehr and Richards.
3. Modern Physics – Ohanian.

MTHR 2106: History of the Liberation War of Bangladesh

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 2106	History of the Liberation War of Bangladesh	Theory	3	70	20	10	30	100

Course Description: History of the Liberation War of Bangladeshis a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Teachers meet twice a week for 1 hour each session; in general, they have no pre-requisites. History lectures usually have additional required discussion sections that meet once a week. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, as well as technology-supported presentations, etc.

Rationale: Bangladesh is a democratic country in South Asia and the successor of the socio-economic and political culture of the Indian subcontinent. It has a lot of geopolitical importance. 'Bangladesh' is the name of an ideal. It is the only state in South Asia that has been born centered on 'Secularism'. During the Cold War, the liberation War of Bangladesh drew the special attention of the superpowers. In the history of the nation-state, the liberation War of Bangladesh is of special importance in the fight against colonialism. But Bangladesh is the only state in the world where the collaborators are still involved in conspiracies. They are obstructing the progress of Bangladeshi ideology. Therefore, it is necessary to study the ideology of Bangladesh, to know who played a pioneering role in the formation of Bangladesh, what was the anti-Bangladesh ideology, what was the form of the liberation war, what was the importance of the liberation war of Bangladesh in the world political arena, etc. This course will give the students knowledge about all this important information about the birth of Bangladesh.

Course Objectives:
The aim of the course is to familiarize students with significant developments in the history of the Liberation War of Bangladesh, through different categories. While the primary focus remains on the liberation struggle, students also study international politics, superpowers as well as international organizations. The purpose is to sensitize students to the existence and desirability of multiple perspectives of liberation struggle through which knowledge about the past is constructed. Probably the most important goal is to enable students about liberation war to cultivate a historically sensitive way of thinking with due regard to time, place, context and roles of human agencies involved. Thus, the students are encouraged to think critically and analyze different perspectives about the liberation struggle of Bangladesh. In the process of helping them achieve the above goals, we hope to enable them to engage critically with the major strands of historical

scholarship in the field, available in secondary texts. The objective is also to inculcate a humanitarian spirit within learners, such that they may develop empathy and compassion while being discerning critical thinkers, all at the same time.

Course Learning Outcomes (CLOs)

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

I. Construct historical narratives;
II. Formulate arguments based on a historiographical engagement;
III. Identify and analyze the significance of historical changes that take place within a society or culture;
IV. Abstract the main arguments/concepts/ideas embedded in scholarly writings about liberation war history;
V. Explain the patterns of transitions;
VI. Explain that while chronology and knowledge of the basic facts of history are necessary, the study of history involves critical evaluation and processing of those facts to arrive at coherent interpretations of the past;
VII. Answer questions write essays and research papers;
VIII. Support and establish arguments with historical evidence;
IX. Participate in discussion and ask thoughtful questions;
X. Learn the formal protocol of academic engagement in a seminar and conference.

Course Content	CLOs	Hrs
1. Definition of Liberation War, Comparative Discussion on Liberation of War of Different Countries with the Liberation War of Bangladesh.	CLO1 CLO8 CLO9	2 Hrs
2. Socio-economic, Cultural and Political Background of the Liberation War.	CLO1 CLO2 CLO3 CLO4 CLO5 CLO7	2 Hrs
3. Role of the Intellectuals for the Construction of Mindset in favor of the Liberation War.	CLO1 CLO4 CLO5 CLO6 CLO7	2 Hrs
4. Election of 1970, Non-cooperation Movement and Declaration of Independence.	CLO1 CLO6 CLO9 CLO 10	3 Hrs
5. Operation Searchlight.	CLO1 CLO6 CLO7	1 Hrs
6. Genocide and Oppression to Women.	CLO1 CLO5	2 Hrs

	CLO7 CLO9	
7. Refugee Crisis.	CLO1 CLO2 CLO3 CLO7 CLO 10	1 Hrs
8. Declaration of Independence and Formation of the Government of Bangladesh.	CLO1 CLO2 CLO4 CLO8 CLO9	1 Hrs
9. Spontaneous Primary Resistance and War.	CLO1 CLO4 CLO8	2 Hrs
10. Mass Media and Public Opinion	CLO1 CLO4 CLO8	2 Hrs
11. Liberation Force: Arms, Training and Youth Camp (Juboshibir)	CLO1 CLO6 CLO8	2 Hrs
12. Role of the Political Parties: Bangladesh, India, Pakistan.	CLO1 CLO2 CLO4 CLO8	4 Hrs
13. Role of Students, Women and Mass People in the Liberation War.	CLO1 CLO4 CLO6 CLO7	2 Hrs
14. Role of the Super Powers and Muslim Countries.	CLO1 CLO2 CLO4 CLO6	3 Hrs
15. Anti Liberation Activities of Peace Committee, Al-Badr, Al-Shams and Killing of Intellectuals.	CLO1 CLO3 CLO6	3 Hrs
16. Trial of Bangabandhu during Imprisonment in the Jail of Pakistan and World Reaction.	CLO1 CLO6 CLO7	2 Hrs
17. Reaction of the Non-resident Bangali and the Civil Societies of Different Countries.	CLO1 CLO6	1 Hrs
18. Role of India in the Liberation War: Government, People and Mass Media.	CLO1 CLO4 CLO6 CLO8	2 Hrs
19. Liberation War: the United Nations and Other International Organizations.	CLO1 CLO6	2 Hrs
20. Formation of Allied Force and Final Victory.	CLO1 CLO6	2 Hrs

	CLO8	
21. Leadership and Contributions of Bangabandhu in the Liberation Struggle.	CLO1 CLO6 CLO8 CLO10	2 Hrs
22. Return to Homeland and Formulation of the Constitution	CLO1 CLO5 CLO6 CLO8	2 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. The Foreshadowing of Bangladesh – Harun-or-Rashid, 2003, The University Press Limited
2. Pakistan: Failure in National Integration – Raunaq Jahan, 1994, The University Press Limited
3. Bangladesh: Emergence of a Nation – A.M.A Muhit, 1978, The University Press Limited
৪. অসমাপ্ত আত্মজীবনী – শেখ মুজিবুর রহমান, ইউপিএল, ২০১১

Reference Books:

1. Bangladesh: Constitutional Quest for Autonomy – 1950-71, Moudud Ahmed, 1976, The University Press Limited
2. The Ayub Khan Era Politics in Pakistan 1958-1969 – Lawrence Ziring,1971, Syracuse University Press
3. The Separation of East Pakistan the Rise and Realization of Bengali Nationalism – Hasan Zaheer, 2001, The University Press Limited
4. Emergence of Bangladesh and the Role of Awami League – Abdul Wadud Bhuiyan, 2011, Cambridge University Press
5. Bangladesh: Constitutional Quest for Autonomy – 1950-71, Moudud Ahmed, 1976, The University Press Limited
6. বাংলাদেশের মুক্তিযুদ্ধ ও ভারতের রাজনৈতিক দল – মোহাম্মদ সেলিম

MTHR 2107: Structured Programming Language

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 2107	Structured Programming Language	Theory	2	35	10	5	15	50

Course Description: Structured Programming Language is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Structured programming language is a programming paradigm aimed at improving the clarity, quality, and development time of a computer program by making extensive use of the structured control flow constructs of selection (if/then/else) and repetition (while and for), block structures, and subroutines. However, this course uses mathematics to understand the nature of computation and to turn that understanding into the next generation of programming languages. This reflects the symbiotic relationship between mathematics, programming, and the design of programming languages.

Course Objectives:
The course objective is to introduce students to the algorithmic way of thinking and problem solving by computers. Issues addressed in class are the notion of algorithm, data representations, algorithm design methods, algorithmic problem-solving. Students learn the fundamental principles of structured programming. Typical characteristics and mechanisms of a structured programming language are introduced and students are introduced to the design and development of structured programs in this language. C programming language is used as the course basis. Lectures are completed by lab practice where theoretical knowledge is applied in an appropriate software environment.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: develop, understand, test, and evolve substantial programs using a modern IDE, and associated configuration tools; use programming approaches that avoid common coding errors; practice fundamental defensive programming; perform individual and team program reviews; use established design principles to organize a software system;
CLO2: know basic knowledge and theoretical methods of solving problems given in mathematical science;
CLO3: understand basic types and the benefits of programs;
CLO4: distinguish language definition from implementation, syntax and parsing from semantics and evaluation;
CLO5: use, implement, and evaluate fundamental data structures and associated algorithms; create, implement, debug, and evaluate algorithms for solving substantial problems;
CLO6: implement any mathematical model for making good quality software.

Course Content	CLOs	Hrs
Program and software: Overview of programming language, programming language generation, structural programming language, Functional programming language, Compiler and interpreter basic, software concepts and its classification.	CLO1 CLO2	6 Hrs
C-Language: Preliminaries, Program constructions, variables and data types in C. Input and output. Character and formatted I/O; Arithmetic Expressions and Assignment statements; Branching Loops and Nested loops; Decision making; Arrays, Functions; Arguments and local variables, Calling Functions and arrays. Recursion and Recursive functions; Structures within a structure, union Pointers; Pointers and structures; Pointer and functions; Pointer and arrays; Operation and Pointer; Pointer and memory addresses; Files; File functions for sequential and Random (I/O).Operations on Bits; Bit Operation; Bit field; Advanced features; Standard and library.	CLO3 CLO4 CLO5 CLO6	24 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Programming in ANSIC – E. Balagurusamy
2. The complete Reterence C – Herbert Schildt

Reference Books:

1. Programming in C – Stephen G. Kochan
2. Teach Yourself C – Herbert Schildt
3. The Ultimate Reference for C contestant – Herbert Schildt

MTHR 2108: Structured Programming Language Lab

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Mid-Evaluation	Class Performance	Sub-total	
MTHR 2108	Structured Programming Language Lab	Lab.	2	35	10	5	15	50

Course Description: Structured Programming Language Lab is a compulsory course alongside theory for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lab sessions which include problem-solving sessions and discussion, tests/quizzes over lab materials, etc.

Rationale: Structured programming language is a programming paradigm aimed at improving the clarity, quality, and development time of a computer program by making extensive use of the structured control flow constructs of selection (if/then/else) and repetition (while and for), block structures, and subroutines. However, this course uses mathematics to understand the nature of computation and to turn that understanding into the next generation of programming languages in terms of practical implementation. This reflects the symbiotic relationship between mathematics, programming, and the design of programming languages.

Course Objectives:

The course objective is to introduce students to the algorithmic way of thinking and problem solving by computer programming using C. Issues addressed in class are the notion of algorithm, data representations, algorithm design methods, algorithmic problem-solving. Students learn the fundamental principles of structured programming. Typical characteristics and mechanisms of a structured programming language lab are introduced and students are capable of the design and development of structured programs in this language. C programming language is used as the course basis in the lab session. Lectures are completed by lab practice where theoretical knowledge is applied in an appropriate software environment.

Course Learning Outcomes (CLOs):

After the completion of the course, students will be able to:

CLO1: familiarize with modern IDE for design and development of C program;
CLO2: understand how to compile, debug and then execute codes;
CLO3: write structured programs using C language;
CLO4: design and convert flowcharts into programs;
CLO5: analyze different source codes and then modify and execute them accordingly;
CLO6: be introduced to a scientific programming language using C both algorithmically and mathematically.

Course Content	CLOs	Hrs
Introduction to Programming Tools: environmental setup for programming; installation of IDEs; compilation and execution programs,	CLO1 CLO2	2 Hrs
Syntax and semantics of C programs: introducing syntax and semantics of C programs; designing modular C programs; introducing different header files; how to use comments or documentation in programs.	CLO2 CLO3	4 Hrs
Variables and data types: scope of variables; defining and initialize of variables; use case and types of variables; different data types, including built-in and user-defined.	CLO2 CLO3	2 Hrs
Operators and expressions: introducing different types of operators in C programs; implementing various kinds of expressions, including mathematical, logical or any business-oriented (e.g., balance sheet calculation or payroll calculation) and scientific expression.	CLO2 CLO3 CLO6	6 Hrs
Conditions and looping: introducing different types of conditional statements such as *if*, *if-else*, *else-if ladder*, and switch case statement; use case and structure of looping statement, including *for*, *while*, *do-while* and nested loops.	CLO2 CLO3 CLO4	10 Hrs
Arrays and matrix: initializing and defining arrays; use case of arrays; matrix operations: addition, subtraction, and multiplication.	CLO2 CLO3	2 Hrs
Functionsand procedures:introducing user-defined and built-in functions(e.g., mathematical, or timer function); designing user-defined functional program.	CLO2 CLO3 CLO5	4 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 10 marks and another 10 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 10 marks. Therefore, continuous assessment for lab consists of one midterm (10 marks), lab performance (10 marks) and assignments (10 marks).In the final examination; students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Programming in ANSIC – E. Balagurusamy
2. The complete Reterence C – Herbert Schildt

Reference Books:

1. Programming in C – Stephen G. Kochan
2. Teach Yourself C – Herbert Schildt
3. The Ultimate Reference for C contestant – Herbert Schildt
4. Engineering and Scientific computing using MATLAB – Sergey E. Lyshevski.
5. Getting Started with MATLAB – Rudra Pratap, Oxford

MTH 2201: Calculus IV

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2201	Calculus IV	Theory	2	35	10	5	15	50

Course Description: Calculus IV is the last part of Calculus which is one of the most fundamental courses for the students of the B.Sc. (Honours) program in Mathematics. In our B.Sc. (Honours) program we subdivide this major field into four parts named Calculus I, Calculus II, Calculus III and Calculus IV taught in the first four consecutive semesters of this program. Calculus IV consists of vector calculus and multiple integrals. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course is an advanced topic of calculus include a review of vector and vector calculus, multiple integrals, line integrals, surface integrals, and theorems of Green, and Stokes' divergence theorem. This course serves as an extension of the traditional calculus and contains additional topics relevant to students majoring in engineering, physics, and applied mathematics.

Course Objectives: This course is designed for students who have completed multivariable calculus and preparing to take analysis and upper-level mathematics and majoring in a science, and engineering program. The main objective of this course is to give the proper understanding of the concepts of multiple (double and triple) integral, vector fields with gradient, divergence and curl, the line integral, surface integral and volume integral to the students. Also give them the interpretation of Green's theorem, the Divergence Theorem and Stoke's theorem with applications.

Course Learning Outcomes (CLOs)

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

CLO1: explain the meaning of double and triple integral;
CLO2: determine the double and triple integral for different types of regions;
CLO3: find the area and volume of any bounded region and solid using a double and triple integral;
CLO4: change the variable in integration by proper use of Jacobians;
CLO5: explain scalar and vector fields with the physical interpretation of gradient, divergence and curl;
CLO6: calculate line, surface and volume integrals;
CLO7: interpret and apply Green's theorem, the Divergence Theorem and Stoke's theorem in proper cases.

Course Content	CLOs	Hrs
Multiple Integration: Double integrals and iterated integrals. Double integrals over nonrectangular regions, Double integrals in polar coordinates, Area by double integrals, Triple integrals and iterated integrals, Volume as a triple integral, Triple integral in cylindrical and spherical coordinates, General multiple integrals, Changes of variables in multiple integrals, Jacobians, Linear Approximation of functions of several variables.	CLO1 CLO2 CLO3 CLO4	16 Hrs
Topics in vector Calculus: Scalar and vector fields; Gradient, divergence and curl and their properties, Line and Volume and Surface integrals, Independence of paths, Green's theorem, Surface integrals, The divergence theorem, Stokes' theorem with applications.	CLO5 CLO6 CLO7	14 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Calculus: Early Transcendentals 10/E – Howard Anton, Irl C. Bivens, Stephen Davis.
2. Calculus With Analytic Geometry – E. W. Swokowski

Reference Books:

1. Schaum's Outline Series – Frank Ayres, Elliott Mendelson
2. Calculus: A Rigorous First Course – Daniel J. Velleman
3. Calculus in Context: Background, Basics, and Applications– Alexander J. Hahn

MTH 2202: Linear Algebra I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2202	Linear Algebra I	Theory	2	35	10	5	15	50

Course Description: Linear algebra I is one of the most fundamental courses for the students of the B.Sc. (Honours) program in Mathematics. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Linear algebra is the study of linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. This course will give an overview of linear algebra including the topics of vectors in R^n and C^n, system of linear equations, vector spaces, basis and dimension and the linear transformation. Some applications of linear algebra will be discussed. Also, real-world problems will be analyzed and solved.

Course Objectives: The main objective of this course is to give the basic concepts of vectors in R^n and C^n, the system of linear equations, vector spaces, basis and dimension and the linear transformations to the students. Make them competent in solving linear equations, performing matrix algebra, calculating determinants, and finding eigenvalues and eigenvectors. On the theoretical side, the student will come to understand a matrix as a linear transformation relative to a basis of a vector space. The definite integral from calculus will be revisited and recognized as an inner product. The student will understand the concept of orthogonality of vectors and its use in projecting vectors into subspaces and decomposing vectors into components. Finally, the student will learn how to solve over-constrained systems using the method of least squares.

Course Learning Outcomes (CLOs)

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

I. define vector spaces and the vectors in R^n and C^n with basic properties and determine the distance between two points in R^n and C^n;
II. convert a linear system of equations in matrix form and identify homogeneous and non-homogeneous systems;
III. define groups and fields with their basic properties;
IV. determine the linear combinations of vectors, linear span, linear independence and dependence;
V. define and identify the basis and dimension of vector spaces and explain the row space, column space and null spaces;
VI. determine the row rank, column rank, nullity and rank of matrices;
VII. describe kernel and image of linear transformation and their properties and find the rank and nullity of linear transformation;
VIII. Apply the solution methods to network flow, electrical networks and balancing chemical equations.

Course Content	CLOs	Hrs
Vectors in R^n and C^n: Review of geometric vectors in R^n and C^n space.	CLO1	3 Hrs
System of Linear Equations: System of linear equations (homogeneous and non-homogeneous) and their solutions. Applications to network flow and Electrical networks, Balancing chemical equations, Polynomial interpolation.	CLO2 CLO3	6 Hrs
Vector Spaces: Notion of groups and fields, Vector space and Subspaces, Linear combinations of vectors, linear span, Linear independence and dependence.	CLO4	6 Hrs
Basis and dimension: Basis and dimension of vector spaces. Row space, column space, null spaces, row rank, column rank, nullity and rank of matrices.	CLO5 CLO6	7 Hrs
Linear Transformation: Linear transformation, Kernel and image of linear transformation and their properties, Rank and nullity of Linear Transformation, Matrix representation of linear transformation, Changes of bases. Applications.	CLO7 CLO8	8 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Elementary Linear Algebra Application Version – Howard Anton and Chris Rorres.
2. Linear Algebra – Seymour Lipschutz (Schaum's Outline Series).

Reference Books:

1. Introduction to Linear Algebra – Gilbert Strang.
2. A Textbook of Linear Algebra – Fatema Chowdhury and Munibur Rahman Choudhary.
3. Linear Algebra – Prof. Amulya Chandra Mondal & GK. Saha.

MTH 2203: Numerical Analysis I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 2203	Numerical analysis I	Theory	2	35	10	5	15	50

Course Description: Numerical analysis is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Numerical analysis is the study of algorithms that use numerical approximation for the problems of analysis. Numerical analysis continues this long tradition of practical mathematical calculations. The modern numerical analysis does not seek exact answers, because exact answers are often impossible to obtain in practice. Instead, much of numerical analysis is concerned with obtaining approximate solutions while maintaining reasonable bounds on errors. This course naturally finds applications in all fields of mathematics, engineering and physical sciences as well.

Course Objectives:
It can be considered as a preparatory course in numerical analysis. Although mathematical in nature, there is also an emphasis on programming techniques for numerical methods. This course introduces and applies numerical methods to solve physical and engineering problems. Techniques include solution method of transcendental equations, interpolation, numerical differentiation and integration, and iterative solution for a system of linear and nonlinear equations. The goal is to cover a wide range of numerical methods to obtain an approximate solution of problems of physics where an exact solution is not available. Broad knowledge is often decisive to choose the right method when developing a new code.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

I. know basic knowledge and theoretical methods of solving problems given in mathematical science;
II. apply an appropriate numerical method to solve any algebraic or transcendental equation;
III. demonstrate the use of interpolation methods to find intermediate values for any given set of points;
IV. explain a derivative at a value by using an appropriate numerical method;
V. use different methods of numerical rules for an integral estimate;
VI. find the numerical solution of a system of linear equations by various iterative methods;

VII. find the numerical solution of a system of nonlinear equations by newton's method;

VIII. analyze the accuracy of common numerical methods and implement formulas to various computer-based algorithms;

Course Content	CLOs	Hrs
Solution of the equation in a single variable: Bisection method, method of false position, fixed-point iteration, Newton-Raphson method, Error analysis for iterative method, Accelerating limit of convergence, algorithms of above methods.	CLO1 CLO2 CLO8	6 Hrs
Interpolation and polynomial approximation: Taylor polynomials, Interpolation (Newton's forward, backward & general interpolation, divided difference interpolation and Lagrange's interpolations, Central difference interpolation formula) and extrapolation.	CLO1 CLO3 CLO8	6 Hrs
Differentiation and Integration: Numerical differentiation, Richardson's extrapolation, Numerical integration, Trapezoidal rule, Simpson's rules, Weddle's rule, Adaptive quadrature method, Gaussian quadrature.	CLO1 CLO4 CLO5 CLO8	7 Hrs
Numerical Solutions of linear systems: Gaussian elimination and backward substitution, Pivoting strategies, Direct factorization of matrices, Jacobi, Gauss-Seidel, SOR methods, Error estimates and eigenvectors.	CLO1 CLO6 CLO8	8 Hrs
Numerical solution of Non-linear system: Fixed point method for functions of several variables, Newton's method.	CLO1 CLO7 CLO8	3 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Numerical Analysis–Richard L. Burden and, J. Douglas Faires.
2. Introduction to Numerical Analysis–S.S. Sastry.

Reference Books:

1. Numerical Solution of Differential Equations, M.K. Jain, New AGE International, 4th Edition, 2019.
2. Numerical Method –E. Balagurusamy.
3. Numerical Analysis–Timothy Sauer.

MTHL 2204: Mathematica Lab II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHL 2204	Mathematica Lab II	Practical	3	70	10	10	10	30	100

Course Description: Mathematica Lab-II is a compulsory Lab course for the students of the B.Sc. (Honours) program which is conducted in a lab. This lab course carries 3 credits and 45 hours of teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes in computers. Tests/quizzes/assignments are taken on programming performance using computers. For programming, different problems are solved in concurrent courses (first year) using Mathematica programming languages.

Rationale: *Mathematica* is a mathematical computation program, used in many scientific, engineering, mathematical and computing fields. It was conceived by Stephen Wolfram and is developed by Wolfram Research of Champaign, Illinois. The Wolfram Language is the programming language used in Mathematica. It is applicable for all engineering disciplines and many natural sciences as well. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Course Objectives:

Mathematica is a high-performance language for technical computing. Mathematica allows mathematical skills to be brought to a technical level. With its many built-in functions, Mathematica allows for complex problems to be solved efficiently and accurately. The goal of this course is to introduce students to the fundamental concepts of scientific programming using Mathematica with the necessary mathematical concepts. This course will provide concepts about the syntax and semantics of Mathematicaincluding data types, control structures, comments, variables, functions, equation solving, plotting, differentiation, integration and other abstraction mechanisms.

Course Learning Outcomes (CLOs):

After the completion of the course, students will be able to:

CLO1: acquire knowledge about scientific programming language using Mathematica with the necessary mathematical concepts;

CLO2: review how to use Mathematica as a programming tool and how to write a program for concurrent courses that is well documented and easy to read;

CLO3: create two- and three-dimensional graphs using Mathematica codes;

CLO4: perform integrals, derivatives, and assign values to variables to solve complex equations using Mathematica codes;

CLO5: solve numerical differential and integral equations using Mathematica codes;

CLO6: solve different real-life mathematical and engineering problems using Mathematica codes.

Course Content	CLOs	Hrs
Multivariate Calculus: Partial Derivatives, Maximum and Minimum Values, The Total Differential, Multiple Integrals	CLO1 CLO2 CLO3	12 Hrs
Ordinary Differential Equations: Analytical Solutions, Numerical Solutions	CLO1 CLO2 CLO4 CLO6	10 Hrs
Linear Algebra: Vectors and Matrices, Matrix Operations, Matrix Manipulation, linear Systems of Equations, Orthogonality, Eigenvalues and Eigenvectors, Diagonalization	CLO1 CLO2 CLO6	12 Hrs
Numerical solution with Mathematica: Root finding methods; Bisection method, method of false position, fixed-point iteration, Newton-Raphson method, solving system of the linear equation; Gaussian elimination and backward substitution, evaluate multiple integrals; trapezoidal rule, Simpson's methods, solution of ODEs of different types; Euler method, Runge-Kutta methods.	CLO1 CLO2 CLO4 CLO5 CLO6	11 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 10 marks and another 10 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 10 marks. Therefore, continuous assessment for lab consists of one midterm (10 marks), lab performance (10 marks) and assignments (10 marks).In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Mathematica- Schaum's Outline Series (2nd Edition).
2. Mathematica-Wolfram Research (Student edition)

Reference Books:

1. Essentials of Programming in Mathematica-Paul Wellin
2. The Student's Introduction to Mathematica and the Wolfram Language-Bruce F. Torrence, Eve A. Torrence

MTHV 2205: Viva-Voce
50 Marks: 02 Credits
Viva Voce on courses taught in the **3rd and 4th**semesters (2nd Year).

MTHR 2206: Methods of Statistics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 2206	Methods of Statistics	Theory	3	70	20	10	30	100

Course Description: Methods of Statistics is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Methods of Statistics.

Rationale: Methods of Statistics are the study of some events or subjects with numerical description. It is a method of analysis and interpretation of data. However, Methods of Statistics refer to techniques and methods. That is, Methods of Statistics is a branch of knowledge that includes an appropriate method of collection of data on a certain problem, its presentation and analysis, and finding out the truth from the results of the analysis.

Course Objectives:

The course contents are designed to give students a clear idea about Survey Methods, Sampling Distribution, Test of Hypothesis, Design of Experiment and Time Series Analysis, Moreover, this course is also designed to give the fundamental concept of estimation theory and hypothesis testing, to obtain approximate values and confidence intervals for the unknown parameters, constructing different hypothesis testing procedures related to parametric, the goodness of fit and analysis of variance tests using appropriate statistical methods and theories. This course has wide application in the solution of problems related to Economics, Social Science, Biological Science, Agricultural Science, Business, Planning, Education and Research.

Course Learning Outcomes (CLOs)

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

CLO1: impart concepts of different types of sampling techniques and errors in sample survey;
CLO2: explain how to draw a sample with an appropriate sample size;
CLO3: be familiar with the concepts of analysis of variance in the design of the experiment;
CLO4: be familiar with the concept of test of hypothesis and different types of tests;
CLO5: able to analyze different types of series and find the future trend of those series;
CLO6: able to use different types of methods for research purposes,

Course Content	CLOs	Hrs
Survey Methods: Concept of population, sample, sampling and sampling frame. Census and surveys, advantages and limitations of sample survey over the census. Sampling and non-sampling errors. Types of sampling, Simple random sampling, Stratified random sampling, Systematic sampling and Cluster sampling.	CLO1 CLO2 CLO6	10 Hrs
Sampling Distribution: Concept of a sampling distribution. χ^2, t, F-statistics and their distributions, Properties and uses of these distributions.	CLO1 CLO2	6 Hrs
Test of Hypothesis: Preliminaries of test of hypothesis, Null and alternative hypotheses, Simple and composite hypotheses. Procedures of testing a hypothesis, Concept of test of significance, Level of significance, One-tailed and two-tailed tests, Test statistic. Testing the significance of a single mean, Single variance, Difference of two means, Ratio of two variances and their confidence intervals. Paired t-test. simple correlation coefficient and regression coefficient tests. Testing the homogeneity of several population means and variances. Test of goodness of fit.	CLO4 CLO5 CLO6	12 Hrs
Design of Experiment: Concepts of Design of experiment and analysis of variance. Principles of experimental design: randomization, replication and local control. Basic designs: CRD, RBD & LSD, Estimation of parameters and analysis of these designs, their relative efficiency.	CLO3 CLO5 CLO6	10 Hrs
Time Series Analysis: Elements of time-series analysis. Measurement of a trend: Freehand smoothing, method of semi-average, Method of moving average and method of least squares. Measurement of seasonal indices.	CLO5 CLO6	7 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Introduction to the Theory of Statistics- McGraw-Hill, Mood, Graybill &Boes.
2. Fundamentals of Mathematical Statistics- Gupta, S.C. and Kapoor, V.K.

Reference Books:

1. Sampling Techniques, Cochran, W.G.
2. Design and Analysis of Experiments (2nd ed.), Wiley, Montgomery, D.C.
3. Experimental design, Wiley, Cochran & Cox.

MTHR 2207: Data Structure

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTHR 2207	Data Structure	Theory	2	35	10	5	15	50

Course Description: Data Structure is a related course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course introduces fundamental data structures and explains abstract data types and their representations based on arrays, pointers and Link lists. It also discusses the advantages and disadvantages of the different types of representations of data types. It introduces algorithms for efficient searching, insertion and deletion using data structures stored in internal memory.

Course Objectives:

It can be considered as a fundamental course in Computer Science. This course explains how data can be stored and organized in a computer's memory in an optimized way by using different types of data structures. The goal of the course is to study data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs to write programs for solving a specific problem. The performance of an application program significantly depends on the choice of an appropriate data structure and algorithm.

Course Learning Outcomes (CLOs)

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

CLO1: describe the importance of data structures and algorithms in a program;
CLO2: explain how different types of data can be organized in a structure;
CLO3: organize a list of data in an array and perform insert, and delete operations on the elements of an array;
CLO4: analyze different types of linked list, do operations like location, insertion and deletion of a node in a linked list;
CLO5: distinguish between Stack and Queue, and implement them using an array as well as linked list;
CLO6: describe the importance of trees, organize data in different types of trees, and perform operations on various kinds of trees;
CLO7: understand the concept of a graph, its representation in memory and some specific operations using graph;
CLO8: apply data structures in some searching and sorting algorithms;
CLO9: analyze data efficiently using an appropriate data structure and perform necessary operations using data structures.

Course Content	CLOs	Hrs
Introduction: concept and importance of data, data structure, the relation between the data structure and algorithm (program), major operations on the data structure. **Array:** Definition of one-dimensional and two-dimensional arrays and their representations, different operations using an array. **Linked List:** Concept of pointers, linearly linked list, doubly linked list, circular linked list. Operation on each type of liked list.	CLO1 CLO2 CLO3 CLO4 CLO9	6Hrs
Stack: Definition of the stack, its implementation using an array and linked list. Prefix to postfix conversion using the stack. Evaluation of mathematical expression using the stack. **Queue:** Concept of the queue, representation of queue using an array and linked list with implementation. Drawbacks for array-based queue and application of queue in the network, the internet, etc.	CLO1 CLO2 CLO5 CLO9	6Hrs
Tree: Definition of different types of trees. Representation of binary tree using an array. Binary tree traversal methods using recursive functions. Binary search tree and different operations on it, The concept of the heap, and different operations on the heap.	CLO1 CLO2 CLO6 CLO9	6Hrs
Graph: The concept of different types of graphs. Representation of graphs using an array. Graph traversal methods. Definition of spanning tree and minimum cost spanning tree. Single source shortest path problem and related algorithm.	CLO1 CLO2 CLO7 CLO9	6Hrs
Searching and Sorting: Definition of searching and algorithms related to searching. The concept of internal and external sorts. Some elementary sorting algorithms (bubble sort, selection sort, insertion sort).	CLO1 CLO2 CLO8 CLO9	6 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Data Structure Schaum Series – Seymour Lipschutz, Seymour Lipschutz Manual, 5th Edition, 2019.
2. Data Structures and Algorithms Made Easy – Narasimha Karumanchi, Paperback, 3rd Edition, 2018.

Reference Books:

1. Algorithm Design – Jon Kleinberg, Eva Tardos, Kindle Edition, 1st Edition, 2019.
2. Fundamentals of Data Structure – Ellis Horowitz, Sartaj Sahni, computer science Press.
3. Data Structures – Richard F, Gilberg, Forouzan, Cengage, 2/e, 2005.

MTHR 2208: Data Structure Lab

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHR 2208	Data Structure Lab	Practical	2	35	5	5	5	15	50

Course Description: Data Structure Labis-related laboratory course for the students of the B.Sc. (Honours) program which is conducted in a lab. This lab. the course carries 2 credits and 28 hours of teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes in computers. Tests/quizzes/assignments are taken on programming performance using computers. For programming, real-world problems are solved by applying different data structures and algorithms in concurrent courses using C/C++ programming languages.

Rationale:

Tointroducethefundamentalconceptofdatastructuresandtoemphasizetheimportanceofdata structures in developing and implementing efficient algorithms. This course concerns practical lessons based on the theoretical knowledge from the course. The lessons demonstrate practical knowledge by performing operations on different fundamental data structures using widely-used programming languages such as C, and C++.

Course Objectives:

This laboratory course will introduce practical knowledge with the operation of how data can be stored and manipulated in a computer's memory in an optimized way. The goal of the course is to practically organize data to assess the choice of data structure's impact on the performance of programs. It will provide guidance to choose an appropriate data structure and algorithm design method for a specified application. This course will provide a concept on the design and analysis of elementary algorithms and implement them using programs to perform operations on data structures.

Course Learning Outcomes (CLOs):

After the completion of the course, students will be able to:

CLO1: gain practical knowledge about the importance of data structure and algorithm as well as the program;

CLO2: organize a list of data in an array and perform operations on the element of an array and implement it;

CLO3: perform operations like location, insertion and deletion of a node in a linked list;

CLO4: develop programs using the concept of Stack and Queue, and implementation of them using an array as well as a linked list;

CLO5: develop a program using recursion and organize data in different types of Trees, perform operations using array-based and linked list-based trees and do practically;

CLO6: represent a graph using a two-dimensional array and linked list to do practical operations on the graph data;

CLO7: implement a few searching and sorting algorithms;

CLO8: create a hash table using array and linked list; store data using a hash function, resolve collision using collision resolution scheme.

Course Content	CLOs	Hrs
Introduction: Implementation of some elementary programs where different types of data are used. **Array:** Implementation of searching, insertion, merging operations using a one-dimensional array. Implementation of some algorithms where two-dimensional arrays are used.	CLO1 CLO2	6Hrs
Linked List: Implementation of algorithms to add a node to a different place of linear linked and doubly linked list. Similarly, development of programs to delete a node from different places of linear and doubly-linked lists.	CLO1 CLO3	6Hrs
Stack: Development of programs to evaluate a mathematical expression using the stack, to convert prefix to postfix expression and evaluate the expression using the stack. **Queue:** Do practical using array-based and linked list-based queues.	CLO1 CLO2 CLO4	6Hrs
Tree: Development of programs to represent binary trees using an array and linked list. Implementation of Binary tree traversal methods using recursive functions. Create a Binary search tree and perform different operations on it. Create heap and perform different operations such as the addition of a node and deletion of root node from the heap. **Graph:** Develop a program to store data of the graph and implement BFS and DFS traversal methods.	CLO1 CLO2 CLO5 CLO6	6Hrs
Searching and Sorting: Implementation of searching and sorting algorithms. **Hashing:** Development of the program to create a hash table to store data in it and implementation of some hash collision resolution schemes.	CLO1 CLO7 CLO8	6 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 5 marks and another 5 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 5 marks. Therefore, continuous assessment for lab consists of one midterm (5 marks), lab performance (5 marks) and assignments (5 marks). In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

3. Data Structure Schaum Series – Seymour Lipschutz, Seymour Lipschutz Manual, 5th Edition, 2019.
4. Data Structures and Algorithms Made Easy – Narasimha Karumanchi, Paperback, 3rd Edition, 2018.

Reference Books:

4. Algorithm Design – Jon Kleinberg, Eva Tardos, Kindle Edition, 1st Edition, 2019.
5. Fundamentals of Data Structure – Ellis Horowitz, Sartaj Sahni, computer science Press.
6. Data Structures – Richard F, Gilberg, Forouzan, Cengage, 2/e, 2005.

MTH 3101: Abstract Algebra I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3101	Abstract Algebra I	Theory	3	70	20	10	30	100

Course Description: Abstract Algebra I is a compulsory course for the students of the B.Sc. program in Mathematics. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Abstract algebra is a common name of the sub-area in mathematics that studies algebraic structures such as groups, rings, fields, modules, vector space and algebras. The study of "Abstract algebra" has been grown out of interest and it is now an essential tool in number theory, geometry, topology, cryptography, coding theory, quantum chemistry and physics.

Course Objectives: The main aim of the course is to introduce the students to basic concepts from abstract algebra, especially the notion of a group. The course will help prepare the students for further study in abstract algebra as well as familiarize them with tools essential in many other areas of mathematics. Another aim of this module is to provide the learner with the skills, knowledge and competencies to carry out their duties and responsibilities in a pure Mathematic environment. Also by the end of this course, students will have encountered some of the most important examples of groups, as well as developing some far-reaching theory "from the ground up", gaining an insight into powerful ideas and learning techniques that are applicable across a wide range of mathematics and science.

Course Learning Outcomes (CLOs)

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

CLO1: learn different kinds of relations such as equivalence relations, binary relations, congruence modulo n and different elements;

CLO2: describe the group, sub-group, order, symmetric groups, permutation groups, alternating groups cyclic group, etc and their related examples;

CLO3: illustrate the topics related to theorems such as Lagrange's, Frobenius counting formula;

CLO4: gather deep knowledge about normal groups, quotient groups, a center of groups, theorems of Homomorphisms and isomorphisms;

CLO5: apply group theory in a real-life phenomenon.

Course Content	CLOs	Hrs
Equivalence relations and equivalence classes. Congruence modulo n. Binary relations, identity element, inverse element.	CLO1	8 Hrs
Groups and subgroups. Order of a group and order of an element of a group. Permutation groups, symmetric groups, alternating groups, Cyclic groups.	CLO2	12 Hrs
Cosets. Lagrange's theorem. Product of cosets. Frobenius counting formula.	CLO3	8 Hrs
Normal subgroups, quotient groups, a centre of a group, Homomorphisms and isomorphisms. The isomorphism theorems	CLO4	12 Hrs
Applications of Groups.	CLO5	5 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Introduction to Abstract Algebra (second edition) – J Wiley 1999- W.K. Nicholson
2. Introduction to Modern Algebra – Neal H Mecoy.

Reference Books:

1. Basic Abstract Algebra – P.B. Bhattachary, J.K.Jain, S.R. NagPaul, 2nd Edition.
2. Abstract Algebra – Hiram Paley and P.M. Weichsel.
3. Modern Algebra – Dewan Kuddus & Md. Mizanur Rahman.

MTH 3102: Real Analysis I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3102	Real Analysis I	Theory	3	70	20	10	30	100

Course Description: Real Analysis I is a compulsory course for the students of the B.Sc. program in Mathematics. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Most of the part of basic and advanced part of mathematics depends on our ability to be able to solve equations or summations of series and so on. Most of the problems are not straightforward and applying poor knowledge most of the time brings the wrong result. It requires knowledge of so-called analysis the foundations for this work started in the name of Real Analysis a course that develops this basic material symmetrically and rigorously in the context of real-valued functions of a real variable.

Course Objectives: This course aims to provide students with the specialist knowledge necessary for basic concepts in Real Analysis. More precisely, it strives to enable students to learn basic concepts about functions of bounded variation, grasps basic concepts about the total variation, learn about Riemann-Stieltjesintegrals, sequences and series of functions.

Course Learning Outcomes (CLOs)

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

CLO1: describe the real numbers from the construction of natural numbers, integers, rational and irrational numbers and predict the concept of field axioms;

CLO2: define functions between sets; equivalent sets; finite, countable and uncountable sets;

CLO3: illustrate the concept of basic topology and calculate the limit superior, limit inferior, and the limit of a sequence;

CLO4: relate the concept limit, continuity and rigorous proof of limit and continuity by the help of epsilon-delta definition;

CLO5: identify the concept of sequence and series and recognize alternating, convergent, conditionally and absolutely convergent series and recognize convergent, divergent, bounded, Cauchy and monotone sequences;

CLO6: manipulate the concept of convergence and divergence and different techniques of determining convergence;

CLO7: apply the ratio, root, limit and limit comparison tests.

Course Content	CLOs	Hrs
Real Numbers as Complete ordered fields: Superimum Principle, Infimum Principle, Dedekind theorem and their equivalence, Archimedean property, Denseness of rational and irrational numbers	CLO1 CLO2	8 Hrs
Topology of real line: Neighborhoods, Open and closed sets, Limit points and Bolzano-Weierstrass theorem, Interior, Boundary and closure, Compact sets, Heine-Borel theorem, Connected sets.	CLO3	12 Hrs
Real sequences: Convergence, Theorems on limits, Sub-sequential limits, Bolzano-Weierstrass theorem for sequences, Limit superior & limit inferior, Monotone sequence, Cauchy sequence, Absolute convergence.	CLO4 CLO5	13 Hrs
Infinite series of real numbers: Convergent and divergent series, Tests for convergence (Comparison test, root test, ratio test, integral test, Raabe's test, Gauss test, logarithmic test).	CLO6 CLO7	12 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Principle of Mathematical Analysis – Walter Rudin.
2. Real Analysis – Sharma & Batista.

Reference Books:

1. Mathematical Analysis – Shanti Narayan.
2. Real Analysis – P.N. Chatterjee.
3. Elementary Analysis – K.A. Ross
4. Introduction to Real Analysis – R.G. Bartle & D. Sherbert.
5. Elementary Real Analysis – Payer Ahmed.

MTH 3103: Complex Analysis

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3103	Complex Analysis	Theory	3	70	20	10	30	100

Course Description: Complex Analysis is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Complex functions have numerous applications in areas such as engineering, physics, differential equations, and number theory, to name just a few. The focus of this course is on the study of holomorphic functions and their most important basic properties. Topics covered are Analytic function, Harmonic functions, Complex integration, Power series of complex terms; Tailor's and Laurent's expansion of complex functions; Taylor's theorem; zeros of holomorphic functions; Residue theorems, Conformal mappings, Physical significance of Conformal mappings, etc.

Course Objectives:
This course is designed to introduce basic notions and methods of a function of a complex variable, analytic functions, complex integrations and residue calculus including branch line integrals. With special emphasis on power series, students will learn complex sequences and the basic theories of the series. They will use these theorems to calculate coefficients, radii and convergence of power series. Students will familiar with the basic properties of analytic functions and apply them to simple examples. They will learn about Cauchy and Morera's theorem and calculate the value of contour integral using Cauchy's theorem and its corollaries.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: demonstrate an understanding of the fundamental concepts of an analytic function, C-R equation, complex integration, Cauchy's theorem, Harmonic functions;
CLO2: discuss complex infinite series: Power series, Taylor and Laurent series;
CLO3: identify different singularities: Pole, zeroes and branch point, branch line;
CLO4: purpose of Residue theorem and evaluation of integrals;
CLO5: compute Contour integration;
CLO6: describe Conformal mapping and bilinear transformations.

Course Content	CLOs	Hrs
Metric properties of the complex plane, Complex functions, Power series of complex terms.	CLO1	6 Hrs
Differentiability of a complex function, analytic functions and their properties, C-R equations, Harmonic functions.	CLO1	7 Hrs
Complex integration: Line integration over rectifiable curves, Winding number, Cauchy's theorem, Cauchy-Goursat theorem, Cauchy integral formula, Fundamental theorem of Algebra, Liouville's theorem, Morera's theorem, Rouche's theorem, arguments theorem, the maximum modulus principle.	CLO1	10 Hrs
Different types of singularities, Singularities, residues, Taylor's and Laurent's expansion, Entire functions, Meromorphic function.	CLO2 CLO3	8 Hrs
Cauchy's residue theorem, Evaluation of integrals by contour integration, Branch points and cuts.	CLO1 CLO4 CLO5	8 Hrs
Conformal mappings, bilinear transformations. Analytic Continuation.	CLO6	6 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Complex Variable and Application – Ruel V. Churchill.
2. Complex Variable – Schaum's Outline Series.

Reference Books:

1. Complex Analysis – Lars Ahlfors, Complex Analysis, McGraw-Hill,1979.
2. Real and Complex Analysis – Walter Rudin, McGraw-Hill, 1986.
3. The Elements of Complex Analysis – B. Choudhary, Wiley

MTH 3104: Ordinary Differential Equations II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3104	Ordinary Differential Equations II	Theory	3	70	20	10	30	100

Course Description: Ordinary Differential Equations II is a compulsory course for the students of the B.Sc. (Hon's) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Calculus-I, Calculus-II and Ordinary Differential Equations.

Rationale: Differential Equations are equations involving derivatives of one or more variables (dependent variables) with respect to another variable (independent variables) or equations involving derivatives of a function or functions. Currently, in the era of astonishing advancement, engineers can create robots, the physicist can describe the motion of waves, pendulums or chaotic systems, while we communicate wirelessly in a vast worldwide network. But underline these modern wonders, are deep and mysteriously powerful, they are called Differential Equations. They are used to describe exponential growth and decay, population growth of species or the change in investment return over time, bank interest, even in radioactive decay problems, continuous compound interest problems, flow problems, continuous compound interest problems, cooling and heating problems, orthogonal trajectories. This course is also used in a specific field such as, in the field of medicine, where differential equations are used for modeling cancer growth or the spread of disease.

Course Objectives:
Most "real life" systems that are described mathematically, be they physical, biological, financial or economic, are described by means of differential equations. Our ability to predict how these systems evolve or behave is determined by our ability to model these systems and find solutions of the equations explicitly or approximately. Every application and differential equation presents its challenges, but there are various classes of differential equations, and for some of these there are established approaches and methods for solving them.

Course Learning Outcomes (CLOs)
On completion of the course, the student should be able to:

CLO1: know the technique to transform n-th order linear differential equations into a system of first-order differential equations;
CLO2: solve the system of first-order linear ordinary differential equations using various methods;
CLO3: explain systems of linear differential equations using the method of elimination, matrix method and eigenvalue technique;
CLO4: obtain the approximate solutions to second-order linear ordinary differential equations in the series form about ordinary and singular points;

CLO5: use power series to solve differential equations;
CLO6: apply Frobenius method to solve ordinary differential equations about singular point;
CLO7: get the solution of the Sturm-Liouville boundary value problem.

Course Content	CLOs	Hrs
System of linear first-order differential equations: Elimination method, Matrix method for homogeneous linear systems with constant coefficients, Variation of parameters, Matrix exponential.	CLO1 CLO2 CLO3	15Hrs
Series solutions of second-order linear equations: Taylor series solutions about an ordinary point, Frobenius series solutions about regular singular points, Series solution of Legendre, Bessel, Laguerre and Hermite equations.	CLO4 CLO5 CLO6	15Hrs
Eigenvalue problems and Sturm-Liouville boundary value problems: Regular Sturm-Liouville boundary value problems, Nonhomogeneous boundary value problems and the Fredholm alternative, Solution by eigenfunction expansion, Green's functions, Singular Sturm-Liouville boundary value problems/Oscillation and comparison theory.	CLO3 CLO7	15Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Differential Equations – Shepley L. Ross.
2. An Introduction to Differential Equation and Applications – Martin Braun.

Reference Books:

1. Introduction to Differential Equations – Denis Zill.
2. Ordinary Differential Equations – F. Brauer& J.A. Nohel.
3. Elementary Differential Equations – Earl D. Rainville, Richard E. Bedient, Philip E. Bedient.

MTH 3105: Numerical Analysis II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3105	Numerical Analysis II	Theory	2	35	10	5	15	50

Course Description: Numerical analysis is a compulsory course for the students of the B.Sc. (Hon's) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Numerical Analysis is the study of algorithm that the numerical approximation for the problems of analysis continuous this long tradition of practical mathematical calculations. The modern numerical analysis does not seek exact answers because exact answers are often impossible to obtain in practice. Instead, much of numerical analysis is concerned with obtaining approximate solutions maintaining reasonable bounds on the error.

Course Objectives: It is a continuous and upgraded part of the Numerical Analysis-I. Although mathematical in nature, there is also an emphasis on programming techniques for numerical methods. Techniques include the approximate solution of initial and boundary value problems from ODE. The goal is to cover a wide range of numerical methods to obtain an approximate solution of problems of physics where an exact solution is not available. It also covers a brief discussion about stability and convergence. Broad knowledge is often decisive to choose the right method when developing a new code.

Course Learning Outcomes (CLOs)

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

CLO1:	enable to solve 1^{st} order 1^{st} degree differential equations using some important methods like Euler's method, Higher-order Taylor's method, implicit and explicit Runge-Kutta methods.
CLO2:	analyze the numerical solution and its stability.
CLO3:	learn about convergence analysis of different numerical methods.
CLO4:	analyze the stability of various single-step methods.
CLO5	analyze the stability of a variety of multi-step methods.
CLO6:	describe the boundary value problem and solve them using a method like the Linear shooting method, shooting method for nonlinear BVP.
CLO7:	find out the real-life applications of this course and the construction of MATLAB programs for numerical solutions.

Course Content	CLOs	Hrs
Numerical methods for initial value problems (ODE): Picard's method, Euler's method, Higher-order Taylor's method, Runge-Kutta methods (implicit and explicit).	CLO1 CLO7	4 Hrs
Analysis of the Numerical Solution: Analysis of the numerical solution of the test equations, absolute stability, relative stability, interval of absolute stability, first-order approximation, second-order approximation, third-order approximation, fourth-order approximation, second-order Pade's (1,1) approximation, fourth-order (2,2) Pade's approximation.	CLO2	6 Hrs
Convergence Analysis of first-order IVP (Single-step Methods): Convergence analysis of the numerical method, convergency of Euler method, backward Euler method, Mid-point/Nystrom method, Heun method, second-order explicit RK method, third-order explicit RK-Nystrom method, classical third order explicit RK method, classical fourth-order explicit RK method, second-order implicit RK method, third-order implicit RK method, fourth-order implicit RK method.	CLO3	6 Hrs
Stability Analysis of first-order IVP (Single-step Methods): Stability condition for single-step method, Stability of forwarding Euler method, backward Euler method, Heun/ Trapezoidal method, classical second-order explicit RK method, classical third order explicit RK method, classical fourth-order explicit RK method, second-order implicit RK method, third-order implicit RK method, fourth-order implicit RK method.	CLO4	6 Hrs
Stability Analysis of first-order IVP (Multi-step Methods): General multi-step method for first-order IVP, consistency, and convergency (root condition) of multi-step methods, and stability.	CLO5	4 Hrs
Boundary Value problem (ODE): Linear shooting method, shooting method for nonlinear BVP.	CLO6 CLO7	4 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Computational Methods in Ordinary Differential Equations – J.D. Lambert, Wiley, Chichester, 1991.
2. Numerical Solution of Differential Equations – M.K. Jain, New AGE International, 4th Edition, 2019.

MTH 3106: Mechanics I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam (2 hours)	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3106	Mechanics I	Theory	2	35	10	5	15	50

Course Description: Mechanics I is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Students should be considered the prerequisite of taking this course that is the basic understanding of Calculus.

Rationale: This course is designed to provide the fundamental concept of mechanics (statics and dynamics) and know the solution procedure of different mathematical problems This course naturally finds applications in all fields of mathematics, engineering and physical sciences as well.

Course Objectives: Learning the engineering approach to problem-solving is one of the more valuable lessons to be learned in an introductory dynamics course. Mechanics is a base of various branches of modern physics, applied mathematics and engineering. A thorough understanding of mechanics serves as a foundation for studying different areas in the sciences. Specifically, this course is concentrated on the behavior of bodies under the action of forces. The basic concept of elementary statics and dynamics. Many important theorems with proof and many worked-out examples. Application and solution procedure of second-order and higher-order linear and non-linear ordinary and partial differential equations.

Course Learning Outcomes (CLOs)

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

CLO1: know basic knowledge and theoretical methods of solving problems given in mathematical science;

CLO2: describe the reduction of coplanar forces, equilibrium of coplanar forces, stable and unstable equilibrium, resultant force, general condition of equilibrium, equation of resultant, astatic equilibrium and its conditions, astatic centre;

CLO3: distinguish between work and virtual work, know the principle of the virtual wok, know the procedure of forming the different equations of virtual work and solution;

CLO4: explain the different techniques to evaluate different formulae for the center of gravity by integration for any arc, area, the surface of revolution and volumes also apply these formulae for different geometric bodies and proofs for known bodies;

CLO5: identify nature of equilibrium at different points of different shapes of bodies, able to find the coordinates of equilibrium;

CLO6: explain the equilibrium of flexible strings and Chains;

CLO7: discuss motion and displacement of particles, speed and velocity of a particle, simple harmonic motion(SHM), periodic time, amplitude and frequency, the motion of a particle towards the earth, apse, compounding of two SHMs, Hook's law, damped SHM, forced and damped forced oscillation;

CLO8: classify different types of solutions of a particle in the plane.

Course Content	CLOs	Hrs
1. General conditions of equilibrium, Principle of virtual work, Stable and unstable equilibrium.	CLO1 CLO2 CLO3	8 Hrs
2. Centre of gravity.	CLO1 CLO4 CLO5	8 Hrs
3. Equilibrium of flexible strings and Chains.	CLO1 CLO6	6 Hrs
4. Rectilinear motion (Simple harmonic motion).	CLO1 CLO7 CLO8	8 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. An Elementary treatise on the Dynamics of a Particle & of a Rigid Body – S.L. Loney.
2. An Elementary Treatise on Statics – S.L. Loney.

Reference Books:

1. Statics – S. L. Loney, K.L. Burman for Raha, 1992.
2. Statics – Ramsey, S.K Jain, CBS,1985.
3. Dynamics – Ramsey, S.K Jain, vol. I and II, CBS, 1985.
4. A first course in Mechanics – Mary Lun.
5. Classical Mechanics – R. Douglas Gregory.
6. From Calculus to Chaos An Introduction to Dynamics – David Acheson.
7. Engineering Mechanics: Dynamics – Andrew Paytel.

MTH 3107: Linear Algebra II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3107	Linear Algebra II	Theory	2	35	10	5	15	50

Course Description: Linear Algebra-II is a compulsory course for the students of the B.Sc. (Honors) program. The course carries 2 credits and 36 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Linear Algebra I.

Rationale: Since the algorithms of linear algebra are central to the theory of scientific computing and numerical analysis, this course is a highly applicable field in mathematics that is useful in mathematics, engineering, chemistry, physics, biology, economics, computer science, etc. Students will build an understanding of vector spaces and subspaces, solve large systems of equations, and connect geometric and algebraic interpretations problems to further their ability to reason abstractly and generalize when appropriate. In 1693, determinants were used by Leibniz and since then the study of linear algebra first emerged which was also used to solve systems of linear equations. Generally, it is analytical geometry which means that almost every topic in this course has a picture associated with it.

Course Objectives: Linear Algebra-II provides students an introduction to the theory and techniques of linear algebra which is a foundation course for all mathematics students, to be followed by other more advanced courses in mathematics. Vector spaces are studied in an abstract setting, examining the concepts of linear independence, span, bases, subspaces, and dimension. Linear transformations eigenvalues and eigenvectors, as well as the kernel and range of a linear transformation, are also studied. In this course, the students will be familiar with the theory and computation of the Jordan canonical form of matrices and linear maps, bilinear forms, quadratic forms. This course develops computational skills so that students can understand theories and proofs.

Course Learning Outcomes (CLOs)

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

CLO1: evaluate eigenvalues and eigenvectors with various applications;
CLO2: find the orthogonal and orthonormal bases;
CLO3: Linear transformation and its matrix representation will explain geometrically;
CLO4: recognize inner product spaces and their properties;
CLO5: locate algebraic and geometric representations of vectors in Rn and their operations;
CLO6: demonstrate abstract thinking and application techniques that can be used in various applications and further studies in advanced mathematics, physics, computer science chemistry or other areas of science.

Course Content	CLOs	Hrs
Eigenvalues and Eigenvectors: Eigenvalues and eigenvectors, Diagonalization, Cayley-Hamilton theorem, Application.	CLO1 CLO6	6 Hrs
Similar Matrices: Canonical forms of matrices, symmetric, orthogonal, Hermitian matrices.	CLO2 CLO3	7 Hrs
Inner Product space: Inner products, Inner product spaces, Orthogonality and orthonormal sets. Linear functions and adjoints, Positive operators, unitary operators, normal operators, Dual Space.	CLO4 CLO5	10 Hrs
Bilinear, quadratic and Hermitian forms: Matrix form of transformations, canonical forms, reduction form, definite and semi definite forms.	CLO3 CLO6	8 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Elementary Linear Algebra Application Version- Howard Anton & Chris Rorres.
2. Linear Algebra-Seymour Lipschutz (Schaum's Outline Series).

Reference Books:

1. Linear Algebra- Prof. Md. Abdur Rahman.
2. Linear Algebra- W.Greub.
3. A Textbook of Linear Algebra – Fatema Chowdhury, Munibur Rahman.

MTH 3201: Abstract Algebra II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3201	Abstract Algebra II	Theory	3	70	20	10	30	100

Course Description: Abstract Algebra II is a compulsory course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Abstract Algebra I.

Rationale: Abstract Algebra II is a continuation of the study of abstract Algebra-I. Topics from the theory of groups, rings, fields, principal ideal domains, Euclidean domains are covered. Specific topics include the fundamental theorem of finite abelian groups, polynomial rings, ideals and factor rings, finite fields, and extension fields. The course then shows focuses on one of the most important examples of a Euclidean ring – the polynomial ring over a field. The fundamental results that transfer from Euclidean rings are restated in context, and the idea of irreducibility is introduced. The course then specializes in the rational field, and several key results concerning polynomials over the rational are proved.

Course Objectives:

Abstract algebra evolved in the twentieth century out of nineteenth-century discoveries in algebra, number theory and geometry. It is a highly developed example of the power of generalization and axiomatization in mathematics. Abstract Algebra II is a partial part of Abstract Algebra and The objective is to develop some concepts of set theory as a useful language for abstract mathematics. Next to introduce to the student some of the basic techniques of rings, subrings, ideals, principal ideals, prime ideals and maximal ideals. Also, introduce Einstein's irreducibility criterion. homomorphism &isomorphism on rings, isomorphism theorem which is important in the study of polynomials and their zeros.

Course Learning Outcomes (CLOs)

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

CLO1: describe Rings, subrings, ideals;
CLO2: explain abstract algebraic construction of number sets and operations and see from where the constructs derive;
CLO3: differentiate between different structures and understand how changing properties give rise to new structures;
CLO4: describe Integral domains, division rings, fields, quotient rings;
CLO5: Principal ideal domains, Euclidean domains, Unique factorization domains;
CLO6: justify the concepts of isomorphism and homomorphism;
CLO7: explain the proofs of propositions arising in the context of abstract algebra;
CLO8: define Characteristic of an integral domain. Prime Fields; structure of prime fields, extension field apply the abstract algebra in real-world life.

Course Content	CLOs	Hrs
1. Rings, subrings, ideals, principal ideals, prime ideals and maximal ideals.	CLO1 CLO2	4 Hrs
2. Integral domains, division rings, fields, quotient rings.	CLO2 CLO3 CLO4	10 Hrs
3. Principal ideal domains, Euclidean domains, Unique factorization domains.	CLO2 CLO5	12 Hrs
4. Polynomial rings, Primitive polynomials (Division algorithm) Einstein's irreducibility criterion.	CLO1 CLO2 CLO4	12 Hrs
5. Characteristic of an integral domain. Prime Fields; structure of prime fields, extension fields.	CLO1 CLO8	5 Hrs
6. Homomorphism & Isomorphism on Rings, Isomorphism Theorem.	CLO3 CLO6	2 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a “3rd examiner” to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Abstract Algebra – Hiram Paley and P.M. Weichsel.
2. Basic Abstract Algebra – P.B. Bhattachary, J.K. Jain, S.R. Nag Paul, 2nd Edition.

Reference Books:

1. Introduction to Abstract Algebra –J Wiley 1999- W.K. Nicholson, second edition.
2. Introduction to Modern Algebra – Neal H Mecoy.
3. Algebra – M. Artin.

MTH 3202: Real Analysis II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3202	Real Analysis II	Theory	3	70	20	10	30	100

Course Description: The Real Analysis II is a compulsory course for the students of the B.Sc. (Hon's) program. It is the continuous part of the Real Analysis-I. The course carries 3 credits and 45 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Most of the part of basic and advanced part of mathematics depends on our ability to be able to solve equations or summations of sequence, series and so on. Most of the problems are not straightforward and applying poor knowledge most of the time brings wrong results. It requires a knowledge of so-called analysis the foundations for this work started in the name of Real Analysis a course that develops this basic material symmetrically and rigorously in the context of real-valued functions of a real variable.

Course Objectives: The main objective of this course is to have a satisfactory discussion of the main concepts of analysis such as convergence, continuity, differentiation and integration which are based on accurately defined number concepts. A proper understanding of the fundamental notion of limit, continuity, derivative, and integral are the basic needs for mathematics students. This understanding is important in both its own right and as a foundation for further deep applications to all of the other courses in the studies of mathematics which is mainly discussed in this course.

Course Learning Outcomes (CLOs)

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

CLO1: learn the basic concept of real continuous function, local and global properties, continuity theorem, maximum-minimum value theorem, uniform continuity;

CLO2: describe the differentiation, some important theorem related to derivatives such as Rolle's theorem, Mean value theorem, Taylor's theorem and their applications;

CLO3: explain the integration of a function of real-valued, Riemann sum and Riemann integral, Conditions for integrability, Darboux theorem, Fundamental theorem of calculus, Mean value theorem for integrals and with related problems;

CLO4: know the basic property of sequence, series, real function and compare the different kinds of series and sequences and test their convergences, limit of a sequence;

CLO5: illustrate Euclidean n- space, Norms, completeness and compactness;

CLO6: realize the implicit function, explicit function, difference them, Multiple Integrals, Jacobian, Fubini's Theorem with some related problems.

Course Content	CLOs	Hrs
Real continuous functions: Local properties, Global properties; global continuity theorem, preservation of compactness, maximum and minimum value theorem, intermediate value theorem, preservation of connectedness, uniform continuity.	CLO1	6 Hrs
Differentiability of real functions: Basic properties, Rolle's theorem, Mean value theorem, Taylor's theorem.	CLO2	10 Hrs
Integration of real functions: Riemann sum and Riemann integral, Conditions for integrability, Properties of integrals, Darboux theorem, Fundamental theorem of calculus, Mean value theorem for integrals, Leibnitz theorem on differentiation under the integral sign, Riemann-Stieltjes integration.	CLO3	12 Hrs
Sequences and series of real functions: Point-wise convergence and uniform convergence, Tests for uniform convergence, Cauchy criterion, Weierstras's M-test, Continuity, Differentiability and integrability of limit functions of sequences and series of functions.	CLO4	12 Hrs
Euclidean n-spaces: Norms in R^n, Distance in R^n, Convergence and completeness, Compactness, Continuous functions and their properties, Implicit function theorem, Multiple Integrals, Jacobian, Fubini's Theorem.	CLO5 CLO6	5 Hrs

Evaluation:70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Elementary Analysis – Kenneth A. Ross.
2. Introduction to Real Analysis – Robert G. Bartle, Donald R. Sherbert
3. Principles of Mathematical Analysis – Walter Rudin.

Reference Books:

1. Real Analysis – P.N. Chatterji
2. Real Analysis – Prof. Haridas Halder

MTH 3203: Differential Geometry

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3203	Differential Geometry	Theory	3	70	20	10	30	100

Course Description: Differential Geometry is a compulsory course for the students of the B. Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Differential Geometry.

Rationale: Differential geometry is the study of geometric properties using differential calculus and integral calculus. The study of the plane, space curves and surfaces in three-dimensional Euclidean space created the basis for the development of differential geometry in the 18^{th} and 19^{th}centuries. Differential geometry has grown into a field concerned more with the geometric structures on differentiable manifolds which have applications in physical science and engineering.

Course Objectives: The main objectives of this course are to state the concepts and language of differential geometry e.g., the properties of a geometric object of space curves and surfaces and their twisting behavior in space. This course is a bridge between vector calculus and differential geometry, the intrinsic mathematics of curved spaces. This course generalizes the geometry of curves and surfaces and how calculus and vector contribute to studying geometrical objects. It also helps to point out the role of differential geometry in mathematics as well as to apply it in problem-solving with differential geometry to diverse situations in physics, engineering, or other mathematical contexts.

Course Learning Outcomes (CLOs)

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

CLO1: explain concepts of curves and surfaces at a high level;
CLO2: demonstrate abstract thinking of the geometry of space curves and surfaces;
CLO3: describe the theory of curves, the definitions, and properties of curvature and torsion;
CLO4: generalize the theory of surfaces and apply the properties of first and second;
CLO5: fundamental forms in different areas of mathematics appraise minimal surfaces;
CLO6: point out surfaces in Euclidean space, tangent spaces and vector fields, fundamental planes;
CLO7: explain the concepts and language of differential geometry and its role in modern mathematics.

Course Content	CLOs	Hrs
Curves in Space: 1. Vector functions of one variable, space curves, unit tangent to a space curve, equation of a tangent line to a curve,	CLO1 CLO2	4 Hrs
2. Osculating plane (or plane of curvature), vector function of two variables, tangent and normal plane for surface $f(x, y, z) = 0$, Principal normal, binomial and fundamental planes,	CLO1 CLO2 CLO6	5 Hrs
3. Curvature and torsion, Serret Frenet's formulae, Theorems on curvature and torsion, Helices and its properties, Circular helix,	CLO3	5 Hrs
4. Spherical indicatrix, Curvature and torsion, Curvature and torsion for spherical indicate, involutes and Evolutes of a given curve, Bertrand's curve.	CLO3	6 Hrs
Surface: 5. Curvilinear coordinates, parametric curves, Metric (first fundamental form), Geometrical interpretation of metric, Relation between coefficients E.F.G. properties of metric, the angle between parametric curves, elements of the area, Second fundamental form, Derivatives of the surface normal (Weingarten equations), Third fundamental form,	CLO1 CLO2 CLO4	12 Hrs
6. Principal sections, Direction and curvature, First curvature, Mean curvature, Gaussian curvature, Normal curvature, Lines of curvature, Centre of curvature,	CLO1 CLO5 CLO6 CLO7	7 Hrs
7. Rodrigue's formula, Condition for parametric curves to be a line of curvature, Euler's theorem, Elliptic, Hyperbolic and parabolic points, Dupin indicatrix.	CLO4 CLO7	6 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added, and final marks are converted into grades.

Text Books:

1. An Introduction to Differential Geometry – L.P. Eisenhart.
2. Differential Geometry – Schaum'sOutline Series.

Reference Books:

1. An Introduction to Differential Geometry – T.J.Willmore.
2. Differential Geometry S. Stamike.
3. Theory and Problems of Differential Geometry – M.M. Lipschutz.
4. Differential Geometry – C. Weatherburn.
5. An Introduction to Differential Geometry – T. J. Willmore, Courier Corporation, 2012.
6. A course in Differential Geometry – W. Klingenberg, Springer-Verlag New York.

MTH 3204: Mechanics II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3204	Mechanics II	Theory	2	35	10	5	15	50

Course Description: Mechanics II is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 2 credits and 30 hours of effective class teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course is designed to provide the fundamental concept of mechanics (statics and dynamics) and know the solution procedure of different mathematical problems. This course helps to develop the self-discipline and work habits necessary to succeed in graduate school as well as in the real world and to use the physical concepts and facility with the mathematical methods of mechanics (statics and dynamics)

Course Objectives: Learning the engineering approach to problem-solving is one of the more valuable lessons to be learned in an introductory dynamics course. Mechanics is a base of various branches of modern physics, applied mathematics and engineering. A thorough understanding of mechanics serves as a foundation for studying different areas in the sciences. Specifically, this course is concentrated on the behavior of bodies under the action of forces.

Course Learning Outcomes (CLOs)

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

CLO1: solve problems of the body in motion using different methods;
CLO2: develop skills in formulating and solving physics problems;
CLO3: understand dynamics of particles in rectangular coordinates;
CLO4: understand and apply the equation of planetary motion;
CLO5: understand moments and products of inertia;
CLO6: understand the kinematics of rigid bodies including rotational motion and angular motion relative to the fixed and rotating reference frame.

Course Content	CLOs	Hrs
1. Motion in a plane, Motion of a particle under a central force.	CLO1 CLO2	7 Hrs
2. Motion in two dimensions.	CLO1 CLO2 CLO3	5 Hrs
3. Motion of a particle in space.	CLO1 CLO2 CLO6	6 Hrs
4. Motion of rigid bodies, Moment of inertia, D'Alembert's principle.	CLO1 CLO2 CLO6	6 Hrs
5. Motion about fixed axes	CLO1 CLO2 CLO6	6 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 5 marks each and 5 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. An Elementary treatise on the Dynamics of a Particle & of a Rigid Body – S.L. Loney.
2. An Elementary Treatise on Statics – S.L. Loney.

Reference Books:

1. Static – Ramsey, S.K Jain.
2. Dynamics – Ramsey, S.K Jain, vol. I and II.
3. A first course in Mechanics – Mary Lun.

MTH 3205: Methods of Applied Mathematics I

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 3205	Methods of Applied Mathematics I	Theory	3	70	20	10	30	100

Course Description: Methods of Applied Mathematics I is a compulsory course for the students of the B.Sc.(Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Ordinary Differential Equations.

Rationale: Methods of Applied Mathematics I is designed to provide the fundamental concept of different special functions and their associate forms as well as to know the solution procedure of different mathematical problems through it. This course naturally finds application in all areas of mathematics, engineering and physical sciences as well.

Course Objectives:

It is an excellent introductory course for the introduction of different types of special functions that arise in Mathematics, Physics and Engineering. Special functions appear as the solutions of differential equations. Because symmetries of differential equations are essential to both Physics and Mathematics, the theory of special functions is closely related to the theory of Lie groups and Lie Algebras, as well as certain topics in Mathematical Physics. Therefore, The objective of this course is to establish a relationship between Mathematical Science and Engineering field.

Course Learning Outcomes (CLOs)

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

CLO1: introduce Gamma and Error functions and their real-life applications;

CLO2: introduce Legendre's differential equation, its a series solution and discusses its various properties;

CLO3: introduce Bessel's differential equation, its series solution and discuss its various properties;

CLO4: introduce Laguerre's differential equation, its series solution and discuss its various properties;

CLO5: introduce Hermite's differential equation, its series solution and discuss its various properties;

CLO6: introduce the Hypergeometric differential equation, its series solution and discuss its various properties.

Course Content	CLOs	Hrs
Special functions: 1. Gamma and Error functions and their real-life applications.	CLO1	5 Hrs
2. Legendre function (Generating function, Recurrence relations, orthogonal properties and other properties of Legendre polynomial, Expansion theorem, Legendre differential equation, Legendre function of the first kind, Legendre function of the second kind, Associated Legendre function).	CLO2	9 Hrs
3. Bessel function (Generating function, Recurrence relations, Bessel differential equation, Integral representations, Orthogonality relations, Modified Bessel function).	CLO3	9 Hrs
4. Laguerre polynomial (Generating function, Rodrigue formula, Orthogonality relations, Recurrence relations, Expansion theorem).	CLO4	9 Hrs
5. Hermite polynomial (Generating function, Rodrigue formula, Orthogonal properties, Hermite differential equation, Recurrence relations, Expansion theorem).	CLO5	9 Hrs
6. Hypergeometric functions, and their properties.	CLO6	4 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Special functions and their application – N. N. Lebedev.
2. Special functions – J. N. Sharma and R.K. Gupta.
3. Mathematical Methods –Md. Abdur Rahman, Vol-I.

Reference Books:

1. Advanced Engineering Mathematics – Erwin Kreyszig.
2. Mathematical Physics – B. D. Gupta.
3. Mathematical Physics – B. S. Rajput.

MTHL 3206: FORTRAN Programming Lab II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHL 3206	FORTRAN Programming Lab II	Practical	2	35	5	5	5	15	50

Course Description: FORTRAN Programming Lab II is a compulsory lab course for the students of the B.Sc. (Honours) program which is conducted in the lab. This lab course carries 2 credits and 30 hours of teaching. Another 6 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes FORTRAN language. Tests/quizzes/assignments are taken on programming performance using computers. Laboratory works based on various problems of numerical analysis I and II using FORTRAN Programming. The prerequisite of taking this course is the successful completion of Numerical Analysis I and Numerical Analysis II.

Rationale: FORTRAN (an abbreviation of "Formula Translation") is one of the oldest programming languages and numeric computing environments which was created in 1957 by John Backus that shortened the process of programming and made computer programming more accessible. It is applicable for all engineering disciplines and many natural sciences as well.

Course Objectives:
The goal of the FORTRAN programming lab is to provide the students with sufficient knowledge to write FORTRAN programs and they will gain general experience that can usually be applied when using any programming language. This lab course will help students to write programming code for various numerical methods for solving problems from calculus, algebra ODE, etc.

Course Learning Outcomes (CLOs):
After the completion of the course, students will be able to write codes using FORTRAN programming language:

CLO1: to find the solution of algebraic equations in a single variable
CLO2: for various numerical interpolation formulae;
CLO3: for various numerical differentiation formulae;
CLO4: for various numerical integration formulae;
CLO5: to find the solution of a system of linear equations;
CLO6: to find the solution of a system of non-linear equations;
CLO7: for solving initial value problems using various numerical methods;
CLO8: for solving boundary value problems using various numerical methods.

Course Content	CLOs	Hrs
1. **Solution of algebraic equations in single variables:** Bisection method, method of false position, fixed-point iteration, Newton-Raphson method	CLO1	4 Hrs
2. **Interpolation and polynomial approximation:** Taylor polynomials, Interpolation (Newtons forward, backward & general interpolation, divided difference interpolation and Lagrange's interpolations, Central difference interpolation formula) and extrapolation.	CLO2	5 Hrs
3. **Differentiation and Integration:** Numerical differentiation, Richardson's extrapolation, Numerical integration, Trapezoidal rule, Simpson's rules, Weddle's rule, Adaptive quadrature method, Gaussian quadrature.	CLO3 CLO4	5 Hrs
4. **Solutions of linear systems:** Gaussian elimination and backward substitution, Pivoting strategies, Direct factorization of matrices, Iterative technique for solving linear systems (Jacobi, Gauss-Seidel, SOR methods).	CLO5	5 Hrs
5. **Solutions of nonlinear systems:** Fixed point method for functions of several variables, Newton's method, Quasi-Newton's method.	CLO6	4 Hrs
6. **Initial value problem for ODE:** Picard's method, Euler's method, Higher-order Taylor's method, Runge-Kutta methods (Order two and four), Multi-step method, variable step-size multistep methods, extrapolation method.	CLO7	4 Hrs
7. **Boundary Value problem:** Linear shooting method, shooting method for nonlinear BVP.	CLO8	3 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 5 marks and another 5 marks are allotted for the lab performance. There shall be at least 2 lab assignments that will carry 5 marks. Therefore, continuous assessment for lab consists of one midterm (5 marks), lab performance (5 marks) and assignments (5 marks). In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. Programming with Fortran – Schaum's Outline Series.
2. Computer Programming in FORTRAN 90 and 95 – V. Rajaraman, PHI Learning Pvt. Ltd., Delhi.
3. FORTRAN: A Structured Disciplined Style – Gordon B. Davis & Thomas R. Hoffmann.

Reference Books:

1. Introduction to Programming with Fortran – Ian Chivers and Jane Sleightholme, Springer.
2. Object-Oriented Programming via Fortran 90/95 – Ed Akin, Cambridge Univ Press.

MTHV 3207: Viva-Voce
50 Marks: 02 Credits.
Viva Voce on courses taught in the **5th and 6th**semesters (3rd Year).

MTH 4101: Theory of Numbers

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4101	Theory of Numbers	Theory	3	70	20	10	30	100

Course Description: Theory of numbers is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: The older term for the theory of numbers is arithmetic. By the early twentieth century, it had been superseded by the "theory of numbers". The theory of numbers is such a charming subject of mathematics that many great mathematicians devoted themselves to it because of its wealth of easily accessible and fascinating questions and its intellectual appeal. German mathematician Carl Friedrich Gauss (1777–1855) said, "Mathematics is the queen of the sciences and theory of numbers is the queen of mathematics."

Until the mid-20th century, the theory of numbers was considered the purest branch of mathematics, with no direct applications to the real world. The advent of digital computers and digital communications revealed that the theory of numbers could provide unexpected answers to real-world problems. At the same time, improvements in computer technology enabled number theory to make remarkable advances in factoring large numbers, determining primes, testing conjectures, and solving numerical problems once considered out of reach.

In contrast to other branches of mathematics, many of the problems and theorems of number theory can be understood by laypersons, although solutions to the problems and proofs of the theorems often require a sophisticated mathematical background.

Course Objectives: The objective of this course is the study of basic structures and properties of integers, primes or other number-theoretic objects in some fashion. It can be considered as a preparatory course in the theory of numbers. The theory of numbers helps improve one's ability of mathematical thinking. Students will be able to apply Euclid's algorithm, able to find integral solutions to specified linear Diophantine equations, able to solve linear congruences and apply the Chinese remainder theorem. Students will be able to apply Euler's, Fermat's and Wilson's theorems. Students will understand the concepts of problems arising in primitive roots and indices.

Course Learning Outcomes (CLOs)

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

CLO1: prove the fundamental theorem of arithmetic;
CLO2: apply division algorithm and Euclidean algorithm;
CLO3: proven results involving divisibility and greatest common divisors;
CLO4: Find integral solutions to specified linear Diophantine equations;
CLO5: Understand the definition of congruences, residue classes and residue systems;

CLO6: solve linear congruences and apply the Chinese remainder theorem to solve the system of linear congruences;
CLO7: apply Euler's, Fermat's and Wilson's theorems to prove relations involving prime numbers;
CLO8: understand arithmetical functions, Dirichlet product and multiplicative functions;
CLO9: Prove Mobius inversion formula and Ramanujan's formula;
CLO10: understand Diophantine equation and Fermat equation and prove related theorems;
CLO11: prove two squares and four squares theorems and application of these theorems.

Course Content	CLOs	Hrs
Divisibility, Division algorithm, Euclidean algorithm, Perfect number, Fermat number, Number of divisors, Sum of divisors, Arithmetic in Z, Continued fractions, Linear diophantine equations.	CLO1 CLO2 CLO3 CLO4	12 Hrs
Congruences, Fermat's Theorem, Euler's Theorem, Wilson's and Lagrange's Theorem, Chinese remainder theorem.	CLO5 CLO6 CLO7	12 Hrs
Arithmetical functions, Dirichlet product, Multiplicative function, Mobius inversion formula, Ramanujan's sum.	CLO8 CLO9	11 Hrs
Diophantine equation and the Fermat equation, two squares and four squares theorem.	CLO10 CLO11	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. An Introduction to the Theory of Numbers- Niven, H.S. Zuckerman, John Wiley &Sons Inc.
2. An Introduction to the Theory of Numbers- G. H. Hardy & E.N. Wright, Oxford University Press.

Reference Books:

1. Topics in Number Theory- William J. LeVeque, Dover Publications
2. Elementary Number Theory- D. M. Burton, Mc Graw Hill
3. Essentials of Number Theory- Fatema Chowdhury & Munibur R. Chowdhury, Pi Publications.

MTH 4102: Topology

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4102	Topology	Theory	3	70	20	10	30	100

Course Description: Topology is a compulsory course for the students of the B.Sc. (Hon's) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Topology is the mathematical study of the properties that are preserved through deformations, twistings, and stretchings of objects. Some geometric properties depend not on the exact shape of the objects involved, but rather on the way they are put together. Topology studies such properties that are invariant under certain kinds of transformations (called continuous maps). Nowadays, mathematicians and scientists use topology to model and comprehend real-world occurrences. This has made topology one of the great unifying ideas of mathematics.

Course Objectives:
To acquire the basic idea in the field of analysis, differential equations and differential geometry etcetera one needs to peruse the course topology. The core concepts are based on open and closed sets in an abstract sense. To apply the concept of the mentioned sets to prove the continuity of functions. To practice real-life problem-solving and precision in proof-writing.

Course Learning Outcomes (CLOs)
On completion of the course, the student should be able to:

CLO1: explain the concept of distance function, open and closed sets in a metric space.
CLO2: demonstrate continuous function using the concept of open and closed sets.
CLO3: learn category of metric spaces via Baire's theorem;
CLO4: interpret the basic concepts and theorems on Topology;
CLO5: know about countability of spaces;
CLO6: distinguish which sets can be written as the finite union of open sets and some theorems connected to these sets;
CLO7: differentiate the spaces that cannot be expressed as the union of two disjoint nonempty open subsets and discuss various theorems centering these types of sets.

Course Content	CLOs	Hrs
Metric Spaces: Definition and some examples Open sets, Closed sets, Convergence, Completeness, Baire's theorem, Continuous mappings, Spaces of continuous functions, Euclidean and unitary spaces.	CLO1 CLO2 CLO3	10 Hrs
Topological Spaces: Definition and some examples, Elementary concepts, Bases and sub-bases, Weak topologies, Function algebra. First and second countable spaces.	CLO4 CLO5	10 Hrs
Compactness: Compact spaces, Product spaces, Tychonoff's theorem, Locally compact spaces, Compactness for metric spaces.	CLO6	8 Hrs
Separation: T_i-spaces and Hausdorff spaces, Completely regular spaces and normal spaces.	CLO6	10 Hrs
Connectedness: Connected spaces, Locally connected spaces, Pathwise connectedness, Product Spaces.	CLO7	7 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. General Topology – John L. Kelley.
2. Introduction to Topology and Modern Analysis – G.F. Simmons.
3. Topology and Functional Analysis – M. R. Chowdhury & Fatema Chowdhury.

Reference Books:

1. General Topology – Schaum's outline series.
2. Topology Course Lecture Notes – Aisling McCluskey and Brian McMaster.

MTH 4103: Methods of Applied Mathematics II

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4103	Methods of Applied Mathematics II	Theory	3	70	20	10	30	100

Course Description: Methods of Applied Mathematics II is a compulsory course for the students of the B.Sc.(Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Ordinary and Partial Differential Equations.

Rationale: Methods of Applied Mathematics II is designed to provide the fundamental concept of Fourier series, Fourier transforms and Laplace transforms and to know the solution procedure of 2^{nd} order ordinary and partial differential equations that arise in the science and engineering field.

Course Objectives:

It is an excellent introductory course of the Fourier series, Fourier transforms and Laplace transforms. Any periodic function can be expressed in terms of Fourier series, and using it we can solve both the 2^{nd} order ordinary and partial differential equations such as one-dimensional heat and wave equations as well as two-dimensional Laplace equations. Also, the Laplace and Fourier transform methods are very powerful mathematical techniques for solving ordinary and partial differential equations and also initial and boundary value problems of differential equations arising in Mathematics, Physics and Engineering fields.

Course Learning Outcomes (CLOs)

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

CLO1: introduce the concept of the Fourier series and discuss its different properties;

CLO2: apply the Fourier series to solve both the 2^{nd}order ordinary and partial differential equations;

CLO3: introduce the concept of Fourier transforms and discuss its different properties;

CLO4: apply the Fourier transform to solve the 2^{nd} order partial differential equations such as heat, wave and Laplace equation;

CLO5: introduce the concept of Laplace transforms and discuss its different properties;

CLO6: apply the method of Laplace transform to solve both the ordinary and partial differential equations that arise in the science and engineering field.

Course Content	CLOs	Hrs
Methods of Applied Mathematics II: 1. **Fourier series:** Fourier series and its convergence, Fourier sine and cosine series, properties of Fourier series, Operations on Fourier series, Complex form, Applications of Fourier series, Such as Steady Periodic solution of 2^{nd} order ODE and solution of PDE (Heat and Wave equation).	CLO1 CLO2	14 Hrs
2. **Fourier transforms:** Fourier transforms, Inversion theorem, sine and cosine transforms, Transform of derivatives, Transforms of a rational function, Convolution theorem, Parseval's theorem, Applications to boundary value problems and integral equation.	CLO3 CLO4	12 Hrs
3. **Laplace transforms:** Laplace transforms and application to initial value problems, Application to solve ordinary differential equations, Laplace transforms, Review of basic definitions and properties, Existence theorem, Transforms of derivatives, Relations involving integrals, Transforms of periodic functions, Transforms of convolutions, Inverse transform, Calculation of inverse transforms, Use of contour integration, Applications.	CLO5 CLO6	19 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Fourier Analysis with applications to boundary value problems – M.R. Spiegel.
2. Laplace Transforms – M.R. Spiegel.
3. Advanced Engineering Mathematics – D. G. Zill & M. R. Cullen.

Reference Books:

1. Fourier Series and Boundary Value Problems – R.V. Churchill & J.W. Brown.
2. Advanced Engineering Mathematics – Erwin Kreyszig.
3. Advanced Engineering Mathematics – H. K. Dass.
4. Mathematical Methods – Md. Abdur Rahman, Vol. II.

MTH 4104: Partial Differential Equations

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4104	Partial Differential Equations	Theory	3	70	20	10	30	100

Course Description: Partial Differential Equations is a compulsory course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Calculus and Ordinary Differential Equations.

Rationale: This course equips students with the fundamental tools required in order to solve simple partial differential equations (PDEs). This includes an understanding of how to classify PDEs and what this classification means physically. The method of characteristics is then introduced to solve First order quasi-linear PDEs. Then the course focuses on solving second order PDEs (mainly the heat equation, the wave equation, and Laplace's equation), first analytically by employing separation of variables.

Course Objectives:

The aims of this course are to enable students to:

1. Describe the fundamental concepts of 1st and 2nd order partial differential equations.
2. Define methods to solve linear, non-linear and quasilinear equations.
3. Explain the applications of some special equations and transforms (e.g. Laplace’s, heat, wave equations, Fourier transforms).
4. Solve the boundary value problems consist homogeneous, non-homogeneous and inhomogeneous equations.
5. Find the coordinate systems involving cylindrical and spherical symmetry to solve BVP.

Course Learning Outcomes (CLOs)

On successful completion of this course students will be able to:

CLO1: classify partial differential equations and transform them into canonical form;
CLO2: solve linear partial differential equations of both first and second-order;
CLO3: apply partial derivative equation techniques to predict the behavior of certain phenomena;
CLO4: apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialization;
CLO5: extract information from partial derivative models in order to interpret reality;
CLO6: identify real phenomena as models of partial derivative equations.

Course Content	CLOs	Hrs
First-order equations: Complete integral, General solution, Cauchy problems, Method of characteristics for linear and quasilinear equations, Lagrange's method, Charpit's method for finding complete integrals, Methods for finding general solutions.	CLO1-CLO6	25 Hrs
Second-order equations: Classifications, Reduction to canonical forms, Characteristics curves, Boundary value problems related to linear equations, Laplace's equation, wave equation and the heat equation, Applications of Fourier methods (Coordinate systems and separability, Homogeneous equations, Non-homogeneous boundary conditions, Inhomogeneous equations), Problems involving cylindrical and spherical symmetry, Boundary value problems involving special functions, Transform methods for boundary value problems (Applications of the Laplace transforms. Application of Fourier sine and cosine transforms), Inhomogeneous equations, Solution using Green's functions.	CLO2-CLO6	20 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a “3rd examiner” to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Partial Differential Equations – Schaum’s Outlines Series.
2. Introductions to Partial Differential Equations – I. N. Sneddon.

Reference Books:

1. Partial Differential Equations – J. M. Kar.
2. Ordinary and Partial Differential Equations – M. D. Raisinghania.

MTH 4105: Linear Programming

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4105	Linear Programming	Theory	3	70	20	10	30	100

Course Description: Linear Programming is a compulsory course for the students of the B.Sc. (Honors) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: One of the fundamental areas of mathematics that has extensive use in combinatorial optimization is called linear programming. It is the study for obtaining the optimal solution for a problem with given constraints. In linear programming, one can formulate one real-life problem into a mathematical model and there needs to be extensive mathematical analysis to find the best and economical solution to a problem within all of its limitations or constraints. Finally, this course is certainly a field of applications in mathematics, engineering, economics and physical sciences.

Course Objectives: The objective of linear programming attaining the optimum use of productive resources, how a decision-maker can employ his productive factors effectively by selecting and distributing these resources. It is one of the powerful mathematical tools to improve the quality-decision for decision-makers scientifically. One of the most important objectives of linear programming is how changes in the input parameter values affect the optimal solution that is the basic concept of sensitivity analysis of any mathematical model.

Course Learning Outcomes (CLOs)

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

CLO1: know the basic knowledge and related theorems for solving real-life problems;
CLO2: construct problem formulation and to solve different mathematics tools;
CLO3: demonstrate the different types of solution procedures and interpret the results from different points of view;
CLO4: know how to change the input parameter values affect the optimal outcomes of any mathematical model;
CLO5: explain the real-life applications;
CLO6: generate the computer solution and interpretation the results.

Course Content	CLOs	Hrs
1. Convex Sets and Related Theorem: Basic Concepts, Convex sets, convex functions and related theorems.	CLO1	6 Hrs
2. An Introduction to Linear Programming: A Simple Maximization Problem, Formulation, Graphical Solution Procedure, Extreme Points and the Optimal Solution; A Simple Minimization Problem, Formulation, Graphical Solution Procedure, General Linear Programming Notation and Related theorems of Feasibility and Optimality.	CLO1 CLO2	10 Hrs
3. Linear Programming Simplex Method: An Algebraic Overview of the Simplex Method, Tableau Form, Setting up the Initial Simplex Tableau, Improving the Solution, Solving a Minimization Problem, Special Cases; Big-M Simplex Method and Two-Phase Method.	CLO2 CLO3	10 Hrs
4. Simplex-Based Sensitivity Analysis and Duality: Sensitivity Analysis and Interpretation of Solutions with the Simplex Tableau, Duality, Economic Interpretation of the Dual Variables, Using the Dual to Identify the Primal Solution, Duality of Linear Programming and Related Theorems.	CLO4 CLO6	10 Hrs
5. Applications of Linear Programming: Marketing Applications, Financial Applications, Operations Management Applications, etc.	CLO5 CLO6	9 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. An Introduction to Management Science – David R. Anderson, Dennis J. Sweeney, Thomas
2. Operations Research – Hamdy. A. Taha, Williams, Jeffery D. Camm and Kipp Marin, Macmillan publishing company.

Reference Books:

1. Operations Research – A. Rabindran, D. T. Phillips, J. J. Solberg, John Wiley and Sons.
2. Introduction to Operations Research –B. E. Gillett, McGraw-Hill Publishing Company.
3. Mathematical Programming Techniques – N.S. Kambu.

MTH 4106: Hydrodynamics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4106	Hydrodynamics	Theory	3	70	20	10	30	100

Course Description: Hydrodynamics is a compulsory course for the students of the B.Sc.(Hon's) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is to have the basic concept of physics, complex analysis, vector calculus, differential equations.

Rationale: This course covers the development of the fundamental equations of fluid mechanics and their simplifications for several areas of marine hydrodynamics and the application of these principles to the solution of engineering problems. Topics include the principles of conservation of mass, momentum and energy, lift and drag forces, laminar and turbulent flows, dimensional analysis, added mass, and linear surface waves, including wave velocities, propagation phenomena, and descriptions of real sea waves. Wave forces on structures are treated in the context of design and basic sea-keeping analysis of ships and offshore platforms. Geophysical fluid dynamics will also be addressed including distributions of salinity, temperature, and density; heat balance in the ocean; major ocean circulations and geostrophic flows; and the influence of wind stress.

Course Objectives:
This course is designed for students who have studied some basic physics courses and are familiar with introductory thermodynamics and vector calculus. This course covers the development of the fundamental equations of fluid dynamics and their simplifications for several areas of hydrodynamics and the application of these principles to the solution of realistic problems. Topics include the principles of conservation of mass, momentum, inviscid flows, potential flows, the complex potential of source, sink, doublet and vortex, Joukowski transformation, flow past a circular cylinder, open-channel water flows, surface waves, including wave velocities, propagation phenomena, and description of finite-amplitude waves in shallow water. The objectives of this course are to give a general overview to students about the use of Hydrodynamics in solving realistic problems mathematically. A specific objective is to illustrate examples from everyday experience so that the student can develop an intuitive understanding which can then be applied in other contexts.

Course Learning Outcomes (CLOs)

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

CLO1: explain the purpose of Hydrodynamics modeling in Marine and Ocean Engineering today;
CLO2: explain and demonstrate knowledge and understanding of the main mathematical models to describe Free Surface flows;
CLO3: determine and Explain which mathematical model is adapted for which problem of Hydrodynamics;
CLO4: explain and demonstrate knowledge and understanding of the main aspects of numerical simulation in Hydrodynamics;
CLO5: understand the circulation theorems and find the relation between circulation and vorticity;

CLO6: apply Kelvin's circulation theorem to the study of incompressible, inviscid fluid flows.

Course Content	CLOs	Hrs
Velocity and acceleration of fluid particles, Relation between local and individual rates, steady and unsteady flows, Uniform and non-uniform flows, Streamlines, Path lines.	CLO1 CLO2	6Hrs
Rotational and irrotational flows, Equation of continuity, Equation of continuity in Vector form, Equations of continuity in spherical and cylindrical polar coordinates, Boundary surface.	CLO2 CLO3 CLO4	7Hrs
Euler's equation of motion, Conservative field of force, Lamb's hydrodynamical equations of motion, Bernoulli's equation, Motion under conservative body force, Vorticity equations, Energy equation.	CLO2 CLO3 CLO4	7Hrs
Motion in two dimensions, Stream function, Physical meaning of stream function, Velocity in polar coordinates, Relation between stream function and velocity potential.	CLO2 CLO3 CLO4	6Hrs
Sources, sinks and doublets, Complex potential and complex velocity, stagnation points, Complex potential due to a source and a doublet, Image in two and three dimensions, Stoke's stream function.	CLO2 CLO3	7Hrs
Circle theorem, Blasius theorem, Motion of a circular cylinder, Pressure at a point on a circular cylinder, Application of circle theorem.	CLO5	6Hrs
Circulation and vorticity, Relation between, Kelvin's circulation theorem, Permanence of irrotational motion, equation of energy, Kelvin's minimum energy theorem.	CLO5 CLO6	6Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Theoretical Hydrodynamics – L.M. Milne Thomson.
2. Fluid Mechanics: Fundamentals and Applications –YunusCengel, John Cimbala.
3. Fluid Dynamics – M. D. Raisinghania.

Reference Books:

1. Fluid Mechanics – Frank M. White.
2. Fluid Mechanics – Pijush K. Kundu, Ira M. Cohen, David R Dowlin.
3. Fundamentals of Fluid Mechanics – Bruce R. Munson, Donald F. Young, Theodore H. Okiishi

MTH 4107: Discrete Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4107	Discrete Mathematics	Theory	3	70	20	10	30	100

Course Description: Discrete Mathematics is an offered course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Linear Algebra I.

Rationale::Discrete mathematics is mathematics that deals with discrete objects. Discrete objects are those which are separated from each other. Integers (aka whole numbers), rational numbers (ones that can be expressed as the quotient of two integers), automobiles, houses, people, etc. are all discrete objects. On the other hand real numbers which include irrational as well as rational numbers are not discrete. As you know between any two different real numbers there is another real number different from either of them. So, they are packed without any gaps and cannot be separated from their immediate neighbors. In that sense, they are not discrete. In this course, we will be concerned with objects such as integers, propositions, sets, relations and functions, which are all discrete. We are going to learn concepts associated with them, their properties, and relationships among them among others.

Course Objectives:
This course is an introduction to the study of Discrete Mathematics, a branch of contemporary mathematics that develops reasoning and problem-solving abilities, with an emphasis on proof. Topics include logic, Boolean algebra, mathematical reasoning and proof, combinatorics and graph theory. The subject enhances one’s ability to reason and ability to present a coherent and mathematically accurate argument. This course is intended for students of Applied Mathematics capable of and interested in progressing through the concepts of discrete mathematics in more depth and at an accelerated rate. The objectives of this course are to develop logical thinking with the emphasis of proving statements correctly and the correctness of an argument, to solve the circuit designing problems using Boolean algebra, and to develop skills to solve problems using graph theory. The main objective of this course is to provide basic ideas to identify and apply concepts of logic, Boolean algebra, proof techniques, combinatorics, graphs and trees.

Course Learning Outcomes (CLOs)

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

CLO1: construct simple mathematical proofs and possess the ability to verify them;
CLO2: explain and apply the basic methods of discrete (non-continuous) mathematics;
CLO3: apply Boolean Algebra to construct gates and to minimize the circuits;
CLO4: identify and apply basic concepts of proof techniques, binary relations, graphs and trees;
CLO5: use the mathematical concepts learned to various areas of computer science;
CLO6: solve realistic problems using graphs and/or trees.

Course Content	CLOs	Hrs
Mathematical reasoning: Inference and fallacies, Methods of proof, Recursive definitions, Program verification.	CLO1 CLO2	10 Hrs
Combinatory: Counting principles, Inclusion-exclusion principle, Pigeonhole principle, Generating functions, Recurrence relations, Applications to computer operations.	CLO2 CLO3	12 Hrs
Algorithms on graphs and Tree: Introduction to graphs, Paths (Euler and Hamiltonian Path) and trees, Shortest path problems (Dijkstra's algorithm, Floyd-Warshall algorithm and their comparisons), Spanning tree problems (Kruskal's greedy algorithm, Prim's greedy algorithm and their comparisons).	CLO4 CLO5	15 Hrs
Network flows: Flows and cuts, Flow augmentation algorithm, Application of Max-flow min-cut theorem.	CLO5 CLO6	8 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Discrete Mathematics – Schaum'sOutline Series.
2. Discrete Mathematics and its Applications – Keneth H. Rosen.

Reference Books:

1. Discrete and Combinatorial Mathematics – RP Grimaldi and BV Ramana.
2. Discrete Mathematical Structures – Bernard Kolman, Robert C. Busby, Sharon Cutler Ross
3. Discrete Mathematics – Seymour Lipschutz. (Schaumes Outline series)

MTH 4108: Financial Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4108	Financial Mathematics	Theory	3	70	20	10	30	100

Course Description: Financial Mathematics is a compulsory course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Financial Mathematics has immense importance for scientifically solving the problems of resource allocation. This course focuses on the mathematical properties and wide range of skills such as technology skills, an in-depth understanding of advanced economics concepts as well as knowledge of how the financial and banking sectors operate. Career paths for financial mathematics graduates cover a large area of the financial service industry and include job opportunities in investment banks, hedge funds, consulting firms, investment firms, insurance companies, commercial banks and other corporations.

Course Objectives: Financial Mathematics is a basic introduction to finance and establishes a connection with mathematical concepts. This course demonstrates the behavior of production, market and firm using the concept of marginal productivities, supply-demand analysis, mark up, markdown. Also, mathematical formulae for interests, annuities, amortization and sinking funds help to create the general loan schedule. Mathematical models such as the binomial tree model, Black-Scholes model are derived to show the dynamics of stock markets. Finally, the goal of the study of Financial Mathematics is to equip students with a range of appropriate analytical skills for solving real-world problems, especially for Bangladesh.

Course Learning Outcomes (CLOs)

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

CLO1: be introduced to different topics of financial Mathematics;

CLO2: calculate interest, annuities and make a loan or savings schedule using amortization and sinking fund analysis;

CLO3: demonstrate production, market and firm behavior using the concept of marginal productivities, supply and demand analysis, mark up, markdown;

CLO4: model the stock price using Binomial or Trimial distribution for discrete stock prices;

CLO5: derive Blackschole model for continuous stock values;

CLO6: understand the financial and economical condition of Bangladesh and derive a model that can play an important role in overall development.

Course Content	CLOs	Hrs
1. **Mathematics for Finance:** Simple and compound interest and discounts. Investments in stocks and bonds. Mathematics of real estate. Mathematics of insurance. Elements of actuarial science. Interest rate models: Bond and risk-free interest rate, Bond pricing with known interest rates and dividend payments; Zero-coupon bond pricing; Measure of future values of interest rate; Term structure of interest rate (Yield curve); Annuity; present and future value of an annuity, Amortization and Sinking fund.	CLO1 CLO2	15 Hrs
2. **Mathematics for marketing:** Markup and mark-down. Merchandise and profit. Trade discounts and cash discounts.	CLO1 CLO3	5 Hrs
3. **Mathematics for accounting:** Payroll accounting, financial statement, Inventory and depreciation Distribution of net income.	CLO1 CLO2 CLO3	5 Hrs
4. **Binomial option pricing model:** One-step binomial tree model and a no-arbitrage argument; Risk-neutral valuation; Two-steps binomial trees; Binomial model for stock price; Option pricing on the binomial tree; Matching volatility with u and d; American put option pricing on the binomial tree.	CLO1 CLO4	10 Hrs
5. **Black-Scholes analysis:** Black-Scholes model; Black-Scholes Equation; Boundary conditions for call and put options; Exact solution to Black-Scholes equation; Delta-hedging; the Greek letters; Black-Scholes equation and replicating portfolio; Static and dynamic risk-free portfolio; Option on dividend-paying stock; American and European put option.	CLO5 CLO6	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Mathematics of Finance – L.L.Smail
2. An introduction to Financial Engineering – Marek Capinski and Tomasz Zastawni.

Reference Books:

1. Mathematics of Finance – P.H. Chartes.
2. Business Mathematics – L. W. T. Stafford.

MTH 4201: Functional Analysis

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4201	Functional Analysis	Theory	3	70	20	10	30	100

Course Description: Functional analysis is a compulsory course for the students of the B.Sc. (Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Linear Algebra I, Linear Algebra II, Real Analysis I, Real Analysis II and Topology.

Rationale: Functional Analysis has numerous applications in empirical sciences, particularly in the modern theory of solutions of partial differential equations, approximation theory and so on. This course underpins many mathematical developments for the last hundred years by combining linear algebra with analysis.

Course Objectives:
The main objectives of this course are to:

- focus on ideas from linear algebra and analysis in order to handle infinite-dimensional vector spaces and linear mappings.
- interpret the key ideas of Banach and Hilbert space, L^p-space and so on.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: define and thoroughly explain function spaces, Banach and Hilbert spaces, self-adjoint operators;
CLO2: independently prove and thoroughly explain central theorems;
CLO3: apply the spectral theorem for compact self-adjoint operators and Fredholm'salternative, and decide which properties an operator has;
CLO4: apply Hilbert space-theory, including Riesz' representation theorem and weak convergence, and critically reflect over chosen strategies and methods in problem-solving;
CLO5: independently decide if a linear space is a Banach space;
CLO6: identify and independently use contractions of Banach spaces via Brouwers and Schauders fixed point theorems;
CLO7: from a critical point of view analyze operators from applications.

Course Content	CLOs	Hrs
1. **Function Spaces:** Definition with examples.	CLO1	3 Hrs
2. **Banach Spaces:** Definition and some simple examples, Continuous linear transformations, Hahn-Banach theorem, Natural embedding, Open mapping theorem, Conjugate of an operator.	CLO1 CLO2 CLO4 CLO5	16 Hrs
3. **Hilbert Spaces:** Definition and some simple properties, Orthogonal complements, Orthogonal sets, Conjugate spaces, Adjoint and self-adjoint operators.	CLO1 CLO3 CLO4 CLO7	16 Hrs
4. **Fixed point theory:** Banach contraction principle (with proof), Schauder principle (with proof), Applications (including the proof of existence and uniqueness of the solution of IVP).	CLO2 CLO6 CLO4	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Introduction to Topology and Modern Analysis – George F. Simmons.
2. Introductory Functional Analysis with Applications – Erwin Kreyszig.
3. Topology and Functional Analysis – Munibur Rahman Chowdhury, Fatema Chowdhury.

Reference Books:

1. Functional Analysis – Walter Rudin.
2. Applied Functional Analysis –J. Tinsley Oden, L. Demkowicz.
3. Functional Analysis – K. Yosida

MTH 4202: Tensor Analysis

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4202	Tensor Analysis	Theory	3	70	20	10	30	100

Course Description: Tensor Analysis is a compulsory course for the students of the B.Sc. program in Mathematics. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: This course is designed primarily for those students majoring in mathematics, physics, mechanics, electromagnetic theory, aerodynamics, geophysics, metrology or any of the numerous other fields in which vector methods are applicable. In recent years Tensor has become a basic part of the fundamental mathematical background required of those in engineering, sciences and allied disciplines. It is said that vector and tensor analysis is a natural aid in forming mental pictures of physical and geometrical ideas. A most rewarding language and mode of thought for the physical sciences. The focus, therefore, is to impart useful skills to the students in order to enhance their Mathematical ability in applying vectors and tensors technique to solve problems in applied sciences and to equip them with the necessary skill required to cope with higher levels courses in related subjects.

Course Objectives: The main aim of the course is to introduce students to the fundamentals of tensor algebra and expose students to mathematical applications of tensor algebra to handle diverse problems which occur in real-life situations.

Course Learning Outcomes (CLOs)

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

CLO1: understand vector and tensor algebra and its applications in applied sciences and engineering;

CLO2: know the fundamental mathematics of vector and tensor that are important for higher learning;

CLO3: provide working tools for students in some branches of applied mathematics, physics and geophysics;

CLO4: develops the ability to solve mathematical problems involving vectors and tensors;

CLO5: competently use vector and tensor algebra as a tool in the field of applied sciences and related fields.

Course Content	CLOs	Hrs
Co-ordinates, vector and tensor: Curvilinear coordinates, Kronecker delta, Summation convention, Space of n-dimensions, Euclidean and Riemannian space, Co-ordinate transformation, Contravariant and covariant vector.	CLO1 CLO2	13 Hrs
Riemannian metric and metric tensors: Basis and reciprocal basis vectors, Euclidean metric in three dimensions, Reciprocal or conjugate tensors, Conjugate metric tensor, Associated vectors and tensor's length and angle between two vectors, The Christoffel symbols (1^{st} and 2^{nd} order).	CLO3 CLO4	18 Hrs
Covariant Differentiation of tensors and applications: Covariant derivatives and its higher rank tensor and covariant curvature tensor.	CLO5	14 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Vector and Tensor Analysis – Shaum's Outline Series.
2. Tensor Analysis – B. Spain.

Reference Books:

1. Tensor Analysis – L.S. Sokolnikoss.
2. Theory and Problems of Tensor Analysis – Murray R. Spiegel, SI (Metric) Edition.
3. Applications of Tensor Analysis – A. J. McConnell.

MTH 4203: Astronomy

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4203	Astronomy	Theory	3	70	20	10	30	100

Course Description: Astronomy is an offered course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Geometry and Mechanics.

Rationale: This course is an introductory course about the Sun, stars and galaxies. The course provides a general introduction for students with an interest in the science of astronomy. A broad range of topics is treated briefly in a mostly qualitative manner so that the diverse nature of the subject can be appreciated. The course also offers students an opportunity to learn the basics of astronomical observation.

Course Objectives:

The aims of this course are to enable students to:

1. Produce mathematics graduates with a background in weather, combining the traditional areas of forecasting and theory with the physics of the atmosphere, smaller scales of motion, and climate.
2. Students will develop an understanding of how exchanges of heat, moisture and momentum between the earth's surface and atmosphere affect the meteorology of the tropics and sub-tropics including sea breezes, thunderstorms, tropical cyclones, the monsoon, etc.

Course Learning Outcomes (CLOs)

On successful completion of this course students will be able to:

CLO1: describe the historical basis of our understanding of the solar system;
CLO2: define the sky motions of the Sun, Moon, planets & stars;
CLO3: explain the diversity of worlds in our solar system;
CLO4: describe the scale of the Universe and the relative sizes of the different objects within the Universe;
CLO5: explain how our solar system formed;
CLO6: identify the life cycles of stars and explain the difference between white dwarfs, neutron stars, and black holes.

Course Content	CLOs	Hrs
Sphere and Spherical triangles, The celestial sphere, Problems connected with diurnal motion.	CLO1	03 Hrs
Astronomical refraction, Astronomical instruments, Finding the latitude of the place, Conversion of co-ordinates fixing, The ecliptic and the first point of Aries.	CLO1 CLO2	06 Hrs
Kepler's laws: Equations of time, Unit of time.	CLO1 CLO2	03 Hrs
Geocentric parallax, The moon, Local line, Eclipses.	CLO2 CLO3	06 Hrs
The Solar system.	CLO2 CLO3	06 Hrs
Precession and nutation, Annual parallax, Aberration of light.	CLO3 CLO5	06 Hrs
The Stellar universe.	CLO2 CLO5	06 Hrs
The modern finding of Astronomical Objects.	CLO4 CLO6	06 Hrs
Working process of the Hubble Telescope and its finding.	CLO6	03 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Spherical Trigonometry – Tod Hunter.
2. Astronomy – J. M. Kar.

Reference Books:

1. Astronomy – Sattar and Chowdhury.
2. Introduction to Astronomy – A. F. M. Abdur Rahman.

MTH 4204: Fuzzy Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4204	Fuzzy Mathematics	Theory	3	70	20	10	30	100

Course Description: Fuzzy Mathematics is a compulsory course for the students of the B.Sc. program when the examination committee offers the course. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc.

Rationale: Fuzzy Mathematics is based on fuzzy set theory. Fuzzy set theory is the study of fuzzy logic which is based on fuzzy sets, introduced by L. A. Zadeh in 1965, and symbolic logic. Fuzzy set theory is a generalization of abstract set theory. Because of the generalization, it has a much wider scope of applicability than abstract set theory in solving various kinds of real physical world problems, particularly in the fields of pattern classification, information processing, control, system identification, artificial intelligence, and more generally, decision processes involving uncertainty, impreciseness, vagueness, and doubtful data. The notation, terminology, and concept of Fuzzy Mathematics are helpful for students to obtain primary ideas in studying and solving various kinds of real physical world problems. Applications of Fuzzy Mathematics are widely in all areas of mathematics, civil engineering, mechanical engineering, industrial engineering, computer engineering, reliability, robotics and physical sciences as well.

Course Objectives:
It is an excellent introductory course on Fuzzy Set Theory. The approach to this course is to provide an understanding of the basic mathematical elements of the theory of fuzzy sets. Provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories via alpha-cut and strong alpha-cut representation, the convexity of fuzzy sets, and the Extension Principle for fuzzy sets. To give the notion of fuzzy numbers, arithmetic operations on them, and Lattice of fuzzy Numbers. To give the idea of linear fuzzy equations. Provide the concept of fuzzy relations and operations, similarity fuzzy relation, fuzzy morphism, and fuzzy relation equation. To give the idea of the applications of fuzzy set theory. The main objective of this course is to establish thorough background knowledge on the operations of fuzzy numbers with interval operations and enable them to pursue individual research in solving real-world optimization problems.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: expand basic knowledge of fuzzy set theory, fuzzy logic and differentiate crisp sets and fuzzy sets;

CLO2: gain knowledge of conversion of the fuzzy set to classical set and vice versa via alpha-cut and strong alpha-cut representation, and some additional properties via alpha-cut and strong alpha-cut;

CLO3: describe the decomposition of fuzzy sets and extension principle;

CLO4: understand necessary and sufficient conditions of a fuzzy set to be a fuzzy number and investigate addition, subtraction, multiplication, division, MAX and MIN of two fuzzy numbers;
CLO5: solve fuzzy linear equations for unknown fuzzy numbers;
CLO6: describe different types of Fuzzy relations, domain, range, and inverse, the composition of fuzzy relations, transitive closure, some definitions, and theorems with proofs;
CLO7: gain an idea of applications of fuzzy set theory and learn the methodology of using fuzzy sets in a real-life problem.

Course Content	CLOs	Hrs
Crisp Sets and Fuzzy Sets: An overview of crisps sets; the notion of fuzzy sets; basic concepts of fuzzy sets. An overview of classical logic; fuzzy logic.	CLO1 CLO2	10 Hrs
Operations of Fuzzy Sets: General discussion; fuzzy complement; fuzzy union; fuzzy intersection, combinations of operations; Cuts, Representation theorem, general aggregation operations.	CLO1 CLO2 CLO3	12 Hrs
Fuzzy Arithmetic: Fuzzy numbers, linguistic variables, arithmetic operations on intervals and fuzzy numbers, the lattice of fuzzy numbers, Fuzzy equations.	CLO1 CLO4 CLO5	12 Hrs
Fuzzy Relations: Equivalence and similarity relations, Compatibility or tolerance relations, Orderings, Morphisms, Fuzzy relational equations.	CLO1 CLO6	08 Hrs
Applications of Fuzzy Set Theory.	CLO7	03 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Fuzzy Sets & Fuzzy logics-Theory and Applications – George J Klir & Bo Yuan.
2. Fuzzy Set theory-Foundations and Applications – George J. Klir, U. Clair & Bo Yuan.

Reference Books:

1. Fuzzy Set Theory: Basic Concepts, Techniques and Bibliography – R. Lowen, Springer.
2. Fuzzy Sets Theory and Its Applications – H.J. Zimmermann, Springer.

MTH 4205: Mathematical Modeling in Biology

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4205	Mathematical Modeling in Biology	Theory	3	70	20	10	30	100

Course Description: Mathematical Modeling in Biology is a compulsory offered course for the students of the B.Sc. (Honours)program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Ordinary Differential Equations I and Partial Differential Equations.

Rationale: Mathematical biology is a fast-growing, well-recognized subject and is the most exciting modern application of mathematics. The life sciences are arguably the greatest scientific adventure of the age. Over the last few decades, a series of revolutions in experimental technique have made it possible to ask very detailed questions about how life works, ranging from the smallest, sub-cellular scales up through the organization of tissues and the functioning of the brain and, on the very largest scales, the evolution of species and ecosystems. Mathematics has so far played a small, but honorable part in this development, especially by providing simple models designed to illuminate principles and test broad hypotheses. Mathematical modeling is being applied in every major discipline in the biomedical sciences. A very different application, and surprisingly successful, is in psychology such as modeling various human interactions, escalation to date rape and predicting divorce.

Course Objectives:

The objective of the course is an introduction to the mathematical modeling of biological processes, with emphasis on population biology including ecology, biochemistry and physiology with the technique include difference equations, ordinary differential equations, partial differential equations, stability analysis, phase plane analysis.

Course Learning Outcomes (CLOs)

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

CLO1: use simple ODE models to discuss questions in population dynamics;
CLO2: read, understand and analyze dynamical systems that describe networks of biochemical reactions;
CLO3: gain the ability to understand the continuous and discrete population models for single species;
CLO4: enhance the concept regarding the continuous and discrete population models for two species;
CLO5: develop techniques of Epidemic models and dynamics of infectious diseases;
CLO6: impart the basic concept of Richardson's arms race model, Lorenz model for weather forecasting.

Course Content	CLOs	Hrs
Continuous Population models for single species: Continuous growth models, Delay models, Periodic fluctuations, Harvesting models.	CLO1 CLO2 CLO3	9 Hrs
Discrete Population models for single species: Simple model, Discrete logistic models, Discrete delay models.	CLO1 CLO2 CLO3	8 Hrs
Continuous models for interacting populations: Predator-prey models, Lotka-Volterra systems, Complexity and stability, Periodic behavior, Competition models, Mutualism.	CLO1 CLO2 CLO4	10 Hrs
Discrete growth models for interacting populations: Predator-Prey models, Competition models.	CLO1 CLO2 CLO4	8 Hrs
Epidemic models and dynamics of infectious diseases: Simple epidemic models and practical applications. Richardson's arms race model, Lorenz model for weather forecasting.	CLO5 CLO6	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Mathematical Biology: I. An Introduction – J.D. Murray
2. Essential Mathematical Biology – Nicholas F. Britton.

Reference Books:

1. Tutorials in Mathematical Biosciences I. – D. G. Zill and W. S. Wright, 4th Edition, Jones and Bartlett Pub.
2. Introduction to Population Modeling – C. Frauenthal
3. Modeling with Differential Equation – D.N. Burghes and M.S. Borrie.

MTH 4206: Actuarial Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4206	Actuarial Mathematics	Theory	3	70	20	10	30	100

Course Description: Actuarial Mathematics is a course for the students of the B.Sc. program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of MTHR-1207- Introduction to Statistics and Probabilities, FORTRAN Programming Lab I and FORTRAN Programming Lab II.

Rationale: Actuarial science is the discipline that applies mathematical and statistical methods to assess risk in insurance, finance, and other industries and professions. More generally, the Actuarial Mathematics course is designed to provide broad training in the basic mathematics underlying the operations of private and social insurance and employee benefit plans. An actuary is a business professional who analyzes the financial consequences of risk. Actuaries use mathematics, statistics, and financial theory to study uncertain future events, especially those of concern to insurance and pension programs.

Course Objectives:
Actuarial Studies is a broadly-based commerce discipline that involves the study of mathematics, statistics, accounting, economics, and finance, and their application to long-term financial management. Actuarial work is particularly relevant in life and non-life insurance companies (designing insurance products and valuing financial contracts and investing funds); consultancy (offering advice to occupational pension funds and employee benefit plans); government service (supervising insurance companies and advising on the national insurance); and also in the stock exchange, industry, commerce and academia. These problems involve analyzing future financial events, especially where future payments involved have certain or uncertain timing. The traditional areas in which actuaries operate are life and general insurance, pensions, and investment. Actuaries are also increasingly moving into other fields like health insurance, solvency measurements and asset-liability management, financial risk management, mortality and morbidity investigation and so on, where their analytical skills can be employed. Currently, there is high demand for Actuarial Science expertise locally, regionally and internationally.

Course Learning Outcomes (CLOs)
After successful completion of this course, students will be able to:

CLO1: be able to demonstrate a solid foundation in mathematics by their ability to solve a variety of basic and advanced mathematical problems;

CLO2: be able to correctly solve a wide variety of actuarial science problems using both basic and advanced mathematical techniques;

CLO3: be able to deterministic survivorship group and random survivorship group, Continuous computations, Select and Ultimate Tables;

CLO4: learn to apply actuarial mathematics to problems in a variety of fields, including Common Analytical Survival Models, Mixture models;

CLO5: apply actuarial mathematics to problems in a variety of fields, including life insurance, finance, investment, and other businesses;

CLO6: gain practical experience in life annuities, benefit premiums, benefits reserves;

CLO7: be able to demonstrate multiple life functions Markov chains;

CLO8: communicate effectively and clearly both in written and oral forms;

CLO9: apply technology to actuarial problem-solving;

CLO10: gain practical experience in actuarial science through internships, independent projects, or research.

Course Content	CLOs	Hrs
1. Survival models: Survival models, Some actuarial concepts in survival analysis, Force of Mortality, Expectation of life, Curtate failure, Selected survival models, Common Analytical Survival Models, Mixture models.	CLO1 CLO2 CLO4	6 Hrs
2. Life Tables: Life tables, Actuarial Models, Deterministic survivorship group and random survivorship group, Continuous computations, Interpolating life tables, Select and Ultimate Tables.	CLO1 CLO2 CLO3	5 Hrs
3. Life insurance: Introduction to life insurance, Payments paid at the end of the year of death. Further properties of the APV for discrete insurance, Non-level payments paid at the end of the year, Payments at the end of the m-thly time interval, Level benefit insurance in the continuous case. Further properties of the APV for continuous insurance, Non-level payments paid at the end of the year, Computing APV's from a life table.	CLO1 CLO2 CLO5	7 Hrs
4. Life annuities: Whole life annuity, n-year deferred annuity, n-year temporary annuity, n-year certain annuity, Contingencies paid m times a year, Non-level payments annuities, Computing present values from a life table.	CLO1 CLO2 CLO6	7 Hrs
5. Benefit premiums: Funding a liability. Fully discrete benefit premiums. Benefits paid annually funded continuously. Benefit premiums for fully continuous insurance. Benefit premiums for semicontinuous insurance. Benefit premium for an n-year deferred annuity. Premiums paid m times a year. Non-level premiums and/or benefits. Computing benefit premiums from a life table, Premiums found including expenses.	CLO1 CLO6	5 Hrs
6. Benefit reserves: Benefit reserves, Fully discrete insurance. Fully continuous insurance, Reserves for insurance paid immediately and funded discretely, Reserves for insurance paid discretely and funded continuously, Benefit reserves for general fully discrete insurance, Benefit reserves for general fully continuous insurance, Benefit reserves for m-thly paid premiums. Benefit reserves including expenses. Benefit reserves at fractional durations.	CLO1 CLO6 CLO10	5 Hrs
7. Multiple life functions: Multivariate random variables, Joint life status, Last survivor status, Joint survival functions, Common shock model, Insurance for multi-life models, Problems for recent actuarial exams,	CLO7 CLO10	5 Hrs
8. Markov chains: Stochastic processes. Markov chains, Random walks, Hitting probabilities, Gambler's ruin problem, Some actuarial applications.	CLO7 CLO8 CLO9 CLO10	5 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. S. David Promislow – Fundamentals of Actuarial Mathematics.
2. Newton L. Bowers, Hans U. Gerber – Actuarial Mathematics, Society of Actuaries.

Reference Books:

1. S. David Promislow – Fundamentals of Actuarial Mathematics.
2. Newton L. Bowers, Hans U. Gerber – Actuarial Mathematics, Society of Actuaries.
3. http://www.math.binghamton.edu/arcones/450/syllabus.html.

MTH 4207: History of Mathematics

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4207	History of Mathematics	Theory	3	70	20	10	30	100

Course Description: History of Mathematics is an elective course for the students of the B.Sc.(Hon's) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. The prerequisite for this course is an intense interest in mathematics. There are no other prerequisites for it other than a familiarity with plane geometry and algebra.

Rationale: There are many excellent reasons to study the history of mathematics. It helps students develop a deeper understanding of the mathematics they have already studied by seeing how it was developed over time and in various places. It encourages creative and flexible thinking by allowing students to see historical evidence that there are different and perfectly valid ways to view concepts and to carry out computations. Ideally, a History of Mathematics course should be a part of every mathematics major program.

Course Objectives:

- Content goals:
  - follow the development of mathematics from early number systems to the invention of calculus
  - read and understand some historical mathematics
  - survey the development and use of methods of computation, some of which involve tools such as the abacus
  - study the mathematics of various civilizations, their conception and use of mathematics, and how the historical conditions of those civilizations affected and were affected by mathematics
- Historical perspective goals:
  - develop your capacity to understand the contemporary world in the larger framework of tradition and history
  - focus on the problems of interpreting the past and can also deal with the relationship between past and present
  - introduce students to the ways scholars think critically about the past, present and future
- Other goals:
  - Develop your ability to present mathematics and history in spoken and written forms
  - Help you practice research skills
  - Satisfy, in part, your curiosity of how mathematics developed and how it fits into the culture

Course Learning Outcomes (CLOs)

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

CLO1: describe the development of various areas of mathematics within and across various civilizations;
CLO2: describe the changing character of mathematics over time and recognize the distinction between formal and intuitive mathematics;
CLO3: give examples of significant applications of mathematics to commerce, science,and general life, past and present;
CLO4: understand that history includes the interpretation of the past, not just facts;
CLO5: better research historical questions and present your conclusions to others.

Course Content	CLOs	Hrs
Babylonian Mathematics, Egyptian Mathematics, Greek and Roman Mathematics, Indian Mathematics, Arabian Mathematics	CLO1 CLO2 CLO3	6 Hrs
Numeral Systems; History of π, e and zero	CLO1 CLO2 CLO3	6 Hrs
History of Calculus, Trigonometry and Geometry	CLO1 CLO2 CLO3	8 Hrs
Mathematicians: Archimedes, Euclid, Apollonius, Muhammed Al-Khowarizmi, Srinivasa Ramanujan, Brahamagupta, Bhaskara, Isaac Newton, Carl Gauss, Leonhard Euler, Bernhard Riemann, David Hilbert, Lagrange, Gottfried Wilhelm Leibniz, Laplace, Bernoulli's, Joseph Fourier, John Napier, Galois, Augustin-Louis Cauchy	CLO1 CLO2 CLO4 CLO5	20 Hrs
The study of any selected topics	CLO5	5 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. A History of Mathematics, an Introduction – Victor J. Katz.
2. Math Through the Ages: A Gentle History for Teachers and Others – William P. Berlinghoff, Fernando Q. Gouvea
3. The History of Mathematics: An Introduction – David Burton

Reference Books:

1. Journey through Genius: The Great Theorems of Mathematics – William Dunham.
2. A History of Mathematics – Carl B. Boyer, Uta C. Merzbach.
3. Classics of Mathematics – Ronald Calinger.

MTH 4208: Graph Theory

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4208	Graph Theory	Theory	3	70	20	10	30	100

Course Description: Graph Theory is an elective course for the students of the B.Sc.(Honours) program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Linear Algebra I, Linear Algebra II and Discrete Mathematics.

Rationale: Graph theory has had an upsurge of interest and activity for the last few decades in applied mathematics and engineering. This branch of mathematics was born in 1736 historically when Euler's paper solved the Konigsberg bridge problem. Numerous problems cannot be solved directly by attempting an analytical commutation, which requires the physical conversion into a problem of graph theory, and then the graph theory problem is solved, e.g. multicolored problems, four-color problems and so on.

Course Objectives:

The main objectives of this course are to:

- state the mathematical problems in the context of graph theory.
- describe the basic concepts of the graph and various definitions e.g. walk, path, circuits, Euler lines, Hamiltonian path and Hamiltonian circuits.
- explain many physical problems which can be converted to graphs and solved by observing the relevant properties of the corresponding graphs.

Course Learning Outcomes (CLOs)

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

CLO1: state how graph theory represents many problems in terms of geometrical view;
CLO2: describe the main concept of tree's, spanning trees, fundamental circuits and so on;
CLO3: show the idea of connectivity, separability, and vulnerability of graphs;
CLO4: manipulate graph representation algebraically;
CLO5: interpret the use of matrices to represent the graph;
CLO6: perform the coloring of the vertices of a graph optimally;
CLO7: design the applications of graph theory in electrical network analysis, operation research, Markov process and so on.

Course Content	CLOs	Hrs
Introduction: Definition of Graph, Different types of graphs application, history of graph theory.	CLO1 CLO3	5 Hrs
Paths and circuits: Subgraphs, Walks, Paths, Circuits, Euler graphs, Components, Connected and disconnected graphs, Isomorphism, Puzzle with Multicolored cubes, Hamiltonian paths and circuits, The traveling salesman problem.	CLO1 CLO3 CLO4	10 Hrs
Tress and Fundamental circuits: Definition of trees, Properties of trees, Distance and centers in trees, Rooted and Binary trees, Spanning trees, fundamental circuits and cut vertices, Cut sets properties of cut sets, Fundamental circuits and cut sets, Connectivity and separability 1-Isomorphism, 2-Isomorphism.	CLO2 CLO5	10 Hrs
Matrix Representation of Graphs: Incidence matrix, Submatrices of A(G). Circuit matrix. Rank and fundamental circuit matrix, Cut set matrix, Relationships among A_f, B_f and C_f path matrix, Adjacent matrix.	CLO5 CLO7	10 Hrs
Directed graphs: Definition of a directed graph, Types of a directed graph, Digraph and Binary, relations, Directed paths and connectedness, Euler digraphs, fundamental circuits and digraphs Matrices *A, B* and *C* of digraphs, Acyclic digraphs and Decylization.	CLO6 CLO7	10 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Graph Theory – Reinhard Diestel.
2. Pearls in Graph Theory: A Comprehensive Introduction – Nora Hartsfield, Gerhard Ringel.
3. Introduction to Graph Theory – Robin J. Wilson.

Reference Books:

1. Advanced Graph Theory and Combinatorics – Michel Rigo
2. Graph theory with Applications – J. A. Bondy, U. S. R. Murty.
3. A Walk
4. Through Combinatorics: An Introduction to Enumeration and Graph Theory – MiklósBóna

MTH 4209: Mathematical Hydrology

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)				
				Semester Final Exam.	Continuous Assessment			Total
					Two Mid Semester	Performance	Sub-total	
MTH 4209	Mathematical Hydrology	Theory	3	70	20	10	30	100

Course Description: Mathematical Hydrology is an offered course for the students of the B.Sc.program. The course carries 3 credits and 45 hours of effective class teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of traditional lectures which include question-answer sessions and discussion, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of Differential Equations and Hydrodynamics.

Rationale: This course on hydrological processes deals with advanced topics in hydrological processes in catchments at various scales, such as processes and estimation methods for streamflow generation and groundwater (floods and drought development), deterministic and stochastic modeling approaches. The deterministic part deals with precipitation-runoff relationships using physical-mathematical and conceptual models (physically based approaches and reservoir models); examples of flood forecasting and hydrological drought analysis techniques (incl. drought propagation); determination of flow generating processes (quick flow, base flow, influence of groundwater system properties on discharge); determination of the effects of global change on streamflow generation and drought development. The stochastic part deals with black-box models (in particular regression models). The course includes a field trip to Iceland. Hydrological processes will be shown for different conditions (climate, physical catchment structure). The impacts of floods and drought will be elaborated.

Course Objectives:
The aims of this course are to enable students to:

1. Study quantitative and qualitative processes in the atmosphere, oceans and seas, rivers basins, lakes, swamps, water reservoirs.
2. Exercise critical and analytical thinking.
3. Develop scientific research and practical skills, which could be realized in future work related to monitoring of hydrosphere and atmosphere, meteorological and hydrological forecast, water management.
4. Evaluate the climate and water resources.
5. Examine the ecological status.
6. Meet the requirements of the World Meteorological Organization (WMO) for university-level graduate meteorologists and hydrologists and mission of Lithuanian Hydro-meteorological Service.

Course Learning Outcomes (CLOs)
On successful completion of this course students will be able to:

CLO1: Define hydrological processes;
CLO2: Differentiate field observations to conceptualize hydro(geo)logically and climatologically complex catchments;
CLO3: Illustrate hydrological systems (processes and medium) of catchments in various climatological and hydrogeological settings;
CLO4: Point out the precipitation-runoff relationships at various temporal and spatial scales;
CLO5: Use several conceptual models using historical data from several European catchments, incl. a detailed interpretation of model simulation results and inter-comparison of models;

CLO6: Justify outcomes from these models to explore catchment management options, incl. prediction of hydrological extremes (floods and droughts) and assessing effects of global change;

CLO7: sketch the models of stochastic and deterministic nature.

Course Content	CLOs	Hrs
Definition and introduction to hydrology: Hydrologic cycle, Hydrological system model, Hydrologic model classification. The development of Hydrology, Black box model.	CLO1, CLO2	06 Hrs
Hydrologic Processes: Continuity equation, Discrete-time continuity, Momentum equation, Open channel flow, Porous medium flow, Water balances, Precipitation, Evaporation and transpiration, Infiltration and soil moisture, Green-Ampt method, Groundwater in Hydrologic cycle.	CLO3, CLO5	08 Hrs
Rainfall-runoff relations: Sources of streamflow, Excess rainfall and direct runoff, Abstraction using infiltration equation, SCS method for abstraction index method, Travel time, Streamflow Hydrograph, Unit Hydrograph methods and its applications and synthetic unit Hydrograph, Instantaneous Unit Hydrograph (IUH) and its application.	CLO4, CLO6	08 Hrs
Frequency Analysis: Rational method. Empirical formulae, Return period, Extreme value distributions, Frequency analysis using frequency factors. Probability plotting, Time series analysis, Linear channels.	CLO5, CLO6	08 Hrs
Conceptual and Mathematical Models: Nash model, Time area Method, Clerk's model, Dooge's Model, Chow and Kulandaiswany Model, Muskingum Models.	CLO5, CLO7	08 Hrs
Hydrodynamics Models: Saint-Venant Equations from Navier-Stokes Equation, Kinematic Wave (KW) Models, Diffusion Wave Model, Steady dynamic Wave Models, Dynamic Wave Models, Gravity wave models, Flood Forecasting.	CLO5, CLO7	07 Hrs

Evaluation: 70% marks are allotted for the final examination and the remaining 30% is allotted for continuous assessment. There will be two mid-semester examinations carrying 10 marks each and 10 marks are allotted for the class performances/quiz/viva/presentation. In the final examination, students have to answer 5 questions out of 8 questions. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners differ by 20% or more, the examination committee shall recommend a "3rd examiner" to examine such script(s). In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. The sum of the marks of the final examination and continuous assessment is added and final marks are converted into grades.

Text Books:

1. Partial Differential Equations – Schaum's Outlines Series.
2. Introductions to Partial Differential Equations – I. N. Sneddon.

Reference Books:

1. Partial Differential Equations – J. M. Kar.
2. Ordinary and Partial Differential Equations – M. D. Raisinghania.

MTHP 4210: Honours Project

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)		
				Project Report	Project Presentation	Total
MTHP 4210	Honours Project	Practical	3	50	50	100

Course Description:
Honours Project is a compulsory course for the students of the B.Sc. (Honours) program. Each student is required to work on a project and present a project report for evaluation. Such projects should be extensions or applications of materials included in different honours courses and may involve fieldwork and the use of technology. There may be group projects as well as individual projects.

Rationale:
The Honours Project is the preliminary study for report writing and presentation preparation. Different students will have to do different work in their job sector. They need to handle a lot of typing tasks on the computer. Moreover, they will often have to formally present their assignments. On the other hand, a group of students will do a thesis in their Master's program. For them, the Honors Project will be the prerequisite course. Furthermore, a group of students will admit different local/foreign universities for Masters/MPhil/PhD program, where Honours Project will play an important role before and after joining the program. Therefore, this course is fully application-oriented in all areas of career and research as well.

Course Objectives:
Each student is required to work on a project focusing on a specific topic in mathematics. Students develop a skill in analyzing and formulating mathematical concepts that enables them to acquire more comprehensive specialized skills and more advanced knowledge. They gain a broad understanding of the basic concepts and methods of mathematics that develop essential skills in interpreting formulas and solving mathematical problems. Students adapt to independent scientific work by submitting a report in MS word and PowerPoint Presentation. Furthermore, the Honors Project makes them ready to face presentations and oral examinations in front of a panel of experts.

Course Learning Outcomes (CLOs):
After successful completion of this course, students will be able to:
CLO1: explain and analyze mathematical problems independently and confidently;
CLO2: develop mathematical maturity and ability;
CLO3: present things are unshakable;
CLO4: develop presentation skills efficiently and courteously.

Course Content	CLOs	No. of Reports
A particular topic in Mathematics is given by the concerned teacher.	CLO1 CLO2 CLO4 CLO4	15 weekly reports totaling about 40 pages.

Implementation:
The Academic Committee shall appoint a Project Implementation and Coordination Committee (PICC) well before the session begins. The PICC shall consist of a Project Coordinator (PC) and such other members as the Academic Committee considers appropriate. The PC shall invite projects from the teachers before the class started. Each teacher should submit three project proposals which should include a short description of the project. Such project should be an extension or application of materials included in different honours courses and may involve fieldwork and use of technology.
There may be group projects as well as individual projects. For group projects, students will sign up with the PICC in groups of three. These may not be changed later on without the approval of the PICC. The PICC shall assign each group a project. The members of each group shall work independently on the assigned project under the supervision of the concerned supervisors. The PICC shall monitor with the supervisors the progress of different projects and arrange weekly discussions on projects and materials.

Completion:
The project must be completed before the termination of the classes. Each student is required to prepare a separate report on the project. Each report should be of around 40 pages typed on one side of A4 size white paper preferably using word processors. Graphs and figures should be drawn preferably using a computer. Reports of different students working on the same group project should differ in some details and illustrations. The Academic Committee will fix a date for the submission of the project reports to the PICC. Each student must submit three typed copies of her/his project report to the PICC on or before the date fixed for such submission. Any student who fails to submit the report on the due date or to present the thesis on the fixed date will not get any credit for this course.

Evaluation:
The distribution of marks for each project shall be as follows:
Project Report 50 Marks
Project Presentation 50 Marks
Each project report shall be examined by two examiners, one of whom shall be the project supervisor and the other appointed from amongst the teachers of the department on the recommendation of the PICC. The average of the marks given by two examiners (1st and 2nd) shall be taken as final. If the marks given by the 1st and 2nd examiners of a project report differ by 20% or more, the PICC shall recommend a “3rd examiner” to examine such report. In the case of the third examination, the average of the two nearest marks (in case of equal difference, highest two marks) shall be taken as final. Each student is required to present her/his work on the project before the PICC who will evaluate the presentation. The sum of the marks of the project report and project presentation is added and final marks are converted into grades.

The Academic Committee may prepare additional guidelines for the evaluation of the projects. All marks on the projects shall be submitted to the Examination Committee for tabulation with copies to the Controller of Examinations. The project reports shall be returned to the PICC for preservation.

References:
The list of references used in the project report contains boos/thesis/journal papers/conference papers/web resources to be included at the end of the project report.

MTHL 4211: MATLAB

Course No.	Course Title	Course Type	No. of Credits	Evaluation (Marks Distribution)					
				Semester Final Exam.	Continuous Assessment				Total
					One Mid Semester	Assignment	Performance	Sub-total	
MTHL 4211	MATLAB	Practical	3	70	10	10	10	30	100

Course Description: MATLAB is a compulsory Lab. course for the students of the B.Sc. (Honours) program which is conducted in the lab. This practical course carries 3 credits and 45 hours of teaching. Another 9 hours are allocated for individual guidance and contact of the students with the respective course teacher. Teaching techniques consist of lab works in a computer lab which includes doing programming codes in computers. Tests/quizzes/assignments are taken on programming performance using computers. For programming, different problems are solved in concurrent courses (first year to 4th year) using MATLAB programming languages.

Rationale: MATLAB (an abbreviation of "Matrix Laboratory") is a proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. It is applicable for all engineering disciplines and many natural sciences as well. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

Course Objectives:
MATLAB is a high-performance language for technical computing. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. The goal of this course is to introduce students to the fundamental concepts of scientific programming using MATLAB with the necessary mathematical concepts. This course will provide concepts about the syntax and semantics of MATLAB including data types, control structures, comments, variables, functions, equation solving, Plotting, differentiation, integration and other abstraction mechanisms.

Course Learning Outcomes (CLOs):
After the completion of the course, students will be able to:

CLO1: be introduced of a scientific programming language using MATLAB with the necessary mathematical concepts;
CLO2: review how to use MATLAB as a programming tool and how to write a program for concurrent courses that is well documented and easy to read;
CLO3: to know about how to use and create a MATLAB function file and plot a function, graph multivariable functions, compute area, volume, surface area;
CLO4: to find numerically roots of algebraic and system of linear equations using MATLAB codes;
CLO5: solve the numerically differential and integral equation using MATLAB codes;
CLO6: solve different real-life mathematical and engineering problems using MATLAB codes.

Course Content	CLOs	Hrs
The fundamental syntax of MATLAB programming: Script file, function file, input function, inline function, an anonymous function, Array, for loop, do-while loop, summation, else if condition.	CLO1 CLO2	11 Hrs
Various problems solving using MATLAB: Graph multivariable functions, compute area, volume, surface area, circle drawing, temperature conversion grade calculation, finding Fibonacci sequence, get the factorial of a number.	CLO1 CLO2 CLO3 CLO6	10 Hrs
Matrix solution of the linear system using MATLAB: Algebra of matrices, rank, the inverse of matrices, matrix solution of a linear system, eigenvalue, eigenvectors, diagonalization.	CLO1 CLO2 CLO4	10 Hrs
Numerical solution of with MATLAB: Root finding methods; Bisection method, method of false position, fixed-point iteration, Newton-Raphson method, solving system of the linear equation; Gaussian elimination and backward substitution, evaluate multiple integrals; trapezoidal rule, Simpson's methods, solution of ODEs of different types; Euler method, Runge-Kutta methods.	CLO1 CLO2 CLO4 CLO5CLO6	14 Hrs

Evaluation: 70% marks are allotted for a final examination and the rest 30% is allotted for continuous assessment. There will be one mid-term examination carrying 10 marks and another 10 marks are allotted for the performance. There shall be at least 2 assignments that will carry 10 marks. Therefore, continuous assessment for practical consists of one midterm (10 marks), performance (10 marks) and assignments (10 marks). In the final examination, students have to answer 5 questions out of 8 questions. If any report/answer script is produced under practical course, the report shall have to be examined by two examiners (1st & 2nd). The average of the marks given by two examiners shall be taken as final even if the marks differ by 20 percent or more. The sum of the marks of the final examination and continuous assessment is added and final marks are converted to grades.

Text Books:

1. MATLAB- An Introduction with Applications – Amos Gilat
2. Numerical Analysis – Richard L. Burden and-J. Douglas Faires.
3. MATLAB Programming for Numerical Analysis – Cesar Perez Lopez.

Reference Books:

1. An Introduction to Programming and Numerical Methods in MATLAB – S.R.Otto and J.P.Denier.
2. Introduction to MATLAB – Andre Knoesen and Rajeevan Amirtharajah.
3. Engineering and Scientific computing using MATLAB – Sergey E. Lyshevski.
4. Getting Started with MATLAB – Rudra Pratap, Oxford

MTHV 4212: Viva-Voce
50 Marks: 02 Credits
Viva-Voce on courses taught in the 7^{th} and 8^{th} Semesters (4^{th} Year).