Comilla University at a Glance

Comilla University is a well-known public university in Bangladesh with a venerable legacy and international acclaim for its highest academic standards, diverse educational programs, distinguished faculty, illustrious alumni, varied co-curricular activities and modern infrastructure. It was established in 2006 in the green, peaceful and historically famous location of Kotbari, Comilla, Bangladesh. It is the twenty-sixth public university in Bangladesh.

Comilla University has a beautiful and spacious campus covering an area of 250 acres of land. It has well-designed academic buildings, administrative offices, libraries, laboratories, computer centres, and other necessary infrastructural facilities. The University boasts a dedicated team of highly qualified faculty members renowned for their expertise and commitment to teaching and research. It currently has over 272 faculty members and over 7055 active undergraduate and graduate students. All the faculty members of this University encourage an environment of academic curiosity and critical thinking among students, promoting holistic development. The faculty members enhance the University's reputation and contribute to national and international knowledge enhancement through their scholarly contributions, research endeavors, and publications.

Comilla University offers various undergraduate and postgraduate programs in various disciplines. It has 19 departments under six faculties, including the Faculty of Sciences, Faculty of Arts and Humanities, Faculty of Social Sciences, Faculty of Business Studies, Faculty of Engineering, and Faculty of Law. An student can choose any department under these faculties, such as Mathematics, Physics, Chemistry, Statistics, Pharmacy, Computer Science and Engineering, Information and Communication Technology, English, Economics, Public Administration, Bangla, Anthropology, Archaeology, Journalism and Mass Communication, Law, Accounting and Information Systems, Management Studies, Marketing and Finance and Banking.

Furthermore, this University has a modern library which is a valuable resource for students and faculty, housing a vast collection of books, journals, research papers, and digital resources. The computer centres are equipped with the latest technology, providing students access to high-speed internet and a wide range of software applications. Additionally, the campus has residential halls for both male and female students, ensuring a comfortable living environment.

Comilla University follows a semester system examination curriculum, and the academic curriculum is regularly updated to produce competent human resources to meet the demands of the modern job market. The faculty members are highly qualified, experienced, and dedicated to providing quality education. They employ innovative teaching methods, including interactive lectures, group discussions, and practical sessions, to enhance students' learning experiences.

The University also organizes seminars, conferences, and workshops to foster academic discourse and promote research collaboration. Renowned scholars, researchers, industry professionals, and students can exchange ideas and explore new avenues of knowledge creation through these events. Comilla University encourages students to publish their research findings in renowned national and international journals and conferences with a significant contribution.

Apart from academic programs, Comilla University offers various extracurricular activities for students. The university believes in the holistic development of its students. The university has a rich tradition of cultural programs, sports events, and various clubs and societies catering to diverse interests. Sports events allow students to engage in physical activities, fostering teamwork, discipline, and sportsmanship. The clubs and societies cover various interests, including photography, debate, culture, theatre, science, entrepreneurship, journalism, and social work, enabling students to explore their passions outside the classroom. This wide range of cultural, sporting and performance opportunities allows every student access to an environment where they can participate and excel.

Department of Mathematics at a Glance

The Department of Mathematics is one of the primary departments of Comilla University. Its initial setup was laid down, and class work started when this university opened its gates for its students to learn and grow. The Department of Mathematics is established to train students to become competent professionals and researchers by earning B.Sc. (Hons.) and MS degrees in Mathematics.

The Department offers two-degree programs: the B.Sc. (Hons.) degree (with mandatory honours final year research-based project work) and the MS degree (Master by Course work and Master by Mixed-Mode). These degree programs emphasize both fundamental and applied topics in mathematics and computational sciences, including real and functional analysis, numerical solutions for the partial differential equations, numerical analysis, finite element and finite difference methods, relativistic and quantum mechanics, kinetic theory, optimal control, operations research, computational fluid dynamics, dynamical systems, mathematical modeling in biology, nonlinear dynamics, soliton theories, high-performance computing and computing architecture, uncertainty quantification, bioinformatics system, and many more. Undergraduate students can pursue a Bachelor of Science (B.Sc.) in Mathematics, which provides a comprehensive understanding of core mathematical principles and their practical applications. The undergraduate programs cover various topics, including calculus, linear algebra, differential equations, abstract algebra, and statistics. The postgraduate program offers mathematical analysis, differential geometry, functional analysis, and numerical analysis courses. The department also offers some elective courses, which allow students to explore their interests in different areas of mathematics. The elective courses included data analysis, number theory, graph theory, measure theory, econometrics, mathematical modelling and so on.

The department is committed to providing its students with a well-rounded education in mathematics. The curriculum includes courses that cover the theoretical foundations of mathematics and courses that focus on the applications of mathematics to other disciplines. For postgraduate students, the department offers a Master of Science (M.S.) program in Mathematics, enabling them to deepen their knowledge and specialize in various subfields of mathematics. The program emphasizes theoretical foundations, promoting critical thinking and problem-solving abilities.

The Department of Mathematics at Comilla University has made several notable contributions to the field of mathematics. The department has published numerous research papers in reputable national and international journals through its research initiatives. These publications have added to the knowledge of mathematics and have been widely cited by researchers worldwide. The department's faculty members have also been invited to present their research findings at prestigious conferences and seminars. Their presentations and collaborations with scholars from other institutions have facilitated knowledge exchange and the exploration of new research avenues.

The department's commitment to quality education has produced exceptional graduates who have excelled in various fields. Many department alumni have pursued higher studies in renowned institutions worldwide and have gone on to establish successful careers as mathematicians, researchers, educators, and professionals in diverse sectors.

The Department of Mathematics at Comilla University boasts modern facilities that enrich students' academic environment. Equipped with well-decorated lecture halls, computer laboratories, and a comprehensive library. The department ensures students have the necessary resources to excel in their studies. Computer laboratories have advanced mathematical software to facilitate simulations, modelling, and data analysis. Furthermore, the department organizes regular seminars, workshops, and conferences, inviting renowned mathematicians and experts to share their knowledge and insights with the faculty and students. These occasions provide a platform for intellectual discussions, fostering collaboration and creating an atmosphere of continuous learning.

The Department of Mathematics at Comilla University actively promotes research and scholarly activities. The faculty members engage in cutting-edge research in various areas of mathematics, contributing to the development of new mathematical theories, models, and applications. The department encourages students to participate in research projects, attend conferences, and publish their findings in reputable journals. The most emphasizes research area is computational mathematics, numerical analysis of partial differential equations, machine learning, computational fluid mechanics, optimization, fuzzy mathematics, mathematical modeling and so on.

The Department of Mathematics boasts a highly qualified and dedicated faculty comprising professors, associate professors, and assistant professors. The faculty members possess extensive academic backgrounds and research expertise in various branches of mathematics. They actively teach research, and mentor students, creating an intellectually stimulating environment within the department. The faculty members impart theoretical knowledge and emphasize practical applications of mathematics in different domains. Their expertise and guidance enable students to explore the depth and breadth of mathematical concepts, fostering critical thinking, problem-solving skills, and creativity.

The Department of Mathematics at Comilla University has established itself as a centre of excellence for mathematical education and research in Bangladesh. With an outstanding faculty, notable achievements, and world-class facilities, the department provides students with a strong foundation in mathematics. It equips them with the necessary skills to excel academically and professionally. At present, the Department of Mathematics offers M. Phil. and Ph.D. programs. As the department continues to evolve, it remains committed to nurturing the next generation of mathematicians and fostering a culture of innovation and academic excellence.

Name of the Chairmen of the Department Since its Establishment				
SL. No.	**Name**	**Designation**	**From**	**To**
01.	Khalifa Mohammad Helal	Chairman(In-Charge)	01-07-2007	31-10-2007
02.	Professor Dr. M. Zulfikar Ali	Chairman	01-11-2007	28-02-2009
03.	Khalifa Mohammad Helal	Chairman(In-Charge)	11-08-2009	03-10-2011
04.	Mohammad Anwar Hossen	Chairman(In-Charge)	11-10-2011	06-04-2013
05.	Professor Dr. M. Zulfikar Ali	Chairman	07-04-2013	31-03-2015
06.	Dr. Md. Abdul Hakim	Chairman(In-Charge)	01-04-2015	20-03-2017
07.	Dr. Mohammad Anwar Hossen	Chairman	21-03-2017	20-03-2020
08.	Professor Dr. Khalifa Mohammad Helal	Chairman	21-03-2020	11-09-2023
09.	Professor Dr. Mohammad Anwar Hossen	Chairman	12-09-2023	03-03-2025
10.	Professor Dr. Md. Maruf Hasan	Chairman	03-03-2025	27-04-2025
11.	Professor Dr. Md. Abdul Hakim	Chairman	28-04-2025	Till Now

Faculty Members of the Department of Mathematics

Dr. Khalifa Mohammad Helal

Professor

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Research Interest

Applied mathematics, Machine learning, Data analysis, Image processing, Numerical analysis, Computational fluid dynamics, Nonlinear systems.

Dr. Mohammad Anwar Hossen

Professor

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Research Interest

Operations research, Linear programming, Fluid dynamics, Differential equations, Finite element methods, Modeling in Biology.

Dr. Md. Abdul Hakim
Professor

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Research Interest

Inventory models with financial trade credit policy and theory of relativity.

Dr. Md. Maruf Hasan
Professor

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Research Interest

Fluid Dynamics, Mathematical and theoretical analysis of Newtonian and non-Newtonian fluids, Mathematical hydrology, Applied mathematics and nonlinear partial differential equations (PDEs).

Dr. Md. Aman Mahbub
Professor

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Research Interest

Classical topology, Fuzzy mathematics, Fuzzy topology, Relativity, Cosmology, Numerical analysis, partial differential equations (PDEs) and Calculus.

Dr. Md. Ghulam Murtaza Talukder
Professor

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Research Interest

Theoretical and computational approaches of different areas for fluid flow such as Mathematical biology, Engineering medical science, Bio-heat transfer phenomena, Nano-drug delivery system, Bio-fluid flow in the microorganism.

Dr. Md. Abdullah Al Mahbub
Professor

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Research Interest

Computational fluid dynamics, Numerical solution of partial differential equations (PDEs), Finite element methods, Stabilized mixed finite element methods, Finite difference methods, Large scale computations, Mathematical modeling and numerical approximations of the surface and subsurface flows including Navier/Stokes-Darcy models, dual-porosity-Navier/Stokes models, triple-porosity-Navier/Stokes models, fractured porous medium, Closed and open-loop geothermal systems, Blood solute dynamics models, Magnetohydrodynamics (MHD), Mathematical modeling in Biology, and Dynamical systems.

Mohammad Safi Ullah
Associate Professor

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Research Interest

Nonlinear dynamics, Soliton theory, Optics and Fractional calculus.

Dr. Md. Enamul Karim
Associate Professor

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Research Interest

Fluid dynamics, Finite difference methods and Numerical solution of partial differential equations (PDEs).

Zillur Rahman
Associate Professor

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Research Interest

Applied mathematics and Mathematical Physics, Fractional Calculus, Analytical and numerical technique for nonlinear PDEs in Engineering, Fluid Dynamics and Operation Research.

Md. Atiqur Rahman
Assistant Professor

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Research Interest

Operations research, Operations management, Pure Mathematics, Stochastics modeling.

Md. Mohiuddin
Assistant Professor

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Research Interest

Information Theory, Epidemiology, and Blood flow.

Md. Joni Alam
Assistant Professor

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Research Interest

Numerical analysis of partial differential equations (PDEs), Finite difference method, Adaptive mesh refinement, Free boundary problems, Phase transitions and Mathematical modeling.

Jyoti Das
Assistant Professor

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Research Interest

Mathematical biology, Modeling in infectious diseases, Epidemiology, Numerical analysis and Ordinary differential equations.

Humayra Dil Afroz
Assistant Professor

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Research Interest

Optimization problems and Network analysis.

Mahinur Akter
Assistant Professor

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Research Interest

Computational fluid dynamics, Numerical solution of partial differential equations (PDEs), Nonlinear partial differential equations.

Tahia Tazin
Assistant Professor

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Research Interest

Mathematical modeling in fluid mechanics, Numerical solution of partial differential equations (PDEs), Finite element methods, Computational fluid dynamics, Computational heat transfer and Image processing.

Program Self-Assessment Committee (PSAC)		
SL. No.	Name	Designation
01.	Professor Dr. Md. Abdul Hakim	Convener
02.	Professor Dr. Md. Maruf Hasan	Member
03.	Professor Dr. Md. Abdullah Al Mahbub	Member

Committee of Courses			
SL. No.	**Name**	**Designation**	**Signature**
01.	Dr. Md.Abdul Hakim Professor	Chairman	
02.	Dr. Khalifa Mohammad Helal Professor	Member	
03.	Dr. Mohammad Anwar Hossen Professor	Member	
04.	Dr. Md. Maruf Hasan Professor	Member	
05.	Dr. Md. Aman Mahbub Professor	Member	
06.	Dr. Md. Ghulam Murtaza Talukder Professor	Member	
07.	Dr. Md. Abdullah Al Mahbub Professor	Member	
08.	Dr. Md. Enamul Karim Associate Professor	Member	
09.	Mrs. Humayra Dil Afroz Assistant Professor	Member	
10.	Mrs. Mahinur Akter Assistant Professor	Member	
Expert Members			
11.	Professor Dr. Mohammed. Aman Ullah Department of Mathematics University of Chittagong	Member	
12.	Professor Dr. Md. Motaleb Hossain Department of Mathematics University of Dhaka	Member	
13.	Professor Dr. Md. Sahadat Hossain Department of Mathematics University of Rajshahi	Member	

14.	Professor Dr. Pabel Shahrear Department of Mathematics SUST, Sylhet	Member	
Employer and Alumni			
15.	Joynal Abedin, Additional Director, Bangladesh Bank, Head Office, Motijheel, Dhaka	Invited Guest	
16.	Shuchitro Ranjan Das, Additional District Commissioner, Chandpur, Session: 2006-07, Dept. of Mathematics, CoU (Alumni)	Invited Guest	

Title of the Academic Program

Bachelor of Science (Honours) Degree in Mathematics

Program Overview	
Degree	Bachelor of Science (Honours)
Abbreviation form of the degree	B. Sc. (Honours) in Mathematics
Program Offering Entity (POE)	Department of Mathematics
Faculty	Faculty of Science
Awarding Institute	Comilla University
Location	Kotbari, Comilla-3506, Bangladesh
Bangladesh National Qualification Framework (BNQF) Level	07
International Standard Classification Code	0541
Method of Study	Full Time
Language of Study	English
Applicable Session	2024-2025, 2025-2026, 2026-2027

Name of the University

Comilla University

Vision of the University

Comilla University is committed to empowering society, advancing development, promoting human welfare and sustainable planet.

Mission of the University

To meet its vision, Comilla University sets its mission to –

MCoU1	Educate a wide variety of students through effective teaching-learning to achieve academic excellence.
MCoU2	Create an ambience for creative and innovative academic exercise through high-quality research.
MCoU3	Undertake actions regarding collaboration which entails opportunities for long-term interaction with academia and industry for producing competent graduates at the workplace.
MCoU4	Develop human potential to its fullest extent so that intellectually capable and socially responsible leaders can emerge in a range of professions.

MCoU- Mission of Comilla University

Core Values

Comilla University is committed to nurture.

Integrity

The highest level of sincerity and moral, ethical, and professional conducts.

Intellectual Curiosity

Insatiable thirst for knowledge to expand intellectual horizon, go beyond the comfort zone, and bring back wonders for development

Name of the Program Offering Entity

Department of Mathematics

Description of the Program

Department of Mathematics is one of the seven founding departments of this university and the only department in the Faculty of Science with which the University opened its activity in the academic year 2006-2007 on May 28, 2007.

Vision of the Program

The vision of the Department of Mathematics is to provide quality education and research in Pure and Applied Mathematics to fulfill the academic, scientific, social, industrial, technological, and engineering needs by producing competent human resources, which essentially lead us to establish the Department as a center of excellence at the national and international level.

Mission of the Program

To meet its vision, Department of Mathematics sets its mission to-

MDMCoU1	Create the best academic environment to generate a conducive and encouraging domain for the graduates' teaching and learning, which improves their capacity for further studies and avails diverse career opportunities.
MDMCoU2	Undertake actions to achieve a high standard of excellence by generating and propagating innovative, effective, practical and enthusiastic knowledge, whichleads to produce competent human resources.
MDMCoU3	Articulate graduates' knowledge with basic mathematical principles in pure and applied mathematics as well as in the allied arenas, which provide a strong foundation for conducting research for publishing the results and participating in conferences.
MDMCoU4	Enhance critical thinking capacity for modeling the real-world problems mathematically, solve the problems analytically, and achieve efficiency in high-performance computing allowing the graduates to choose a career in academia, industry, financial, and engineering sectors.
MDMCoU5	Develop graduates as mathematical thinkers, enabling them to become lifelong learners, continue to grow in their chosen professions, and be productive and responsible citizens.
MDMCoU6	Acquire the highest professional attitude, integrity, ethics, controlling emotions, and social values for building a dynamic career and meaningful life.

MDMCoU- Mission of the Department of Mathematics Comilla University

Objectives of the Program

Objectives of B. Sc. Degree program in Mathematics are to-

ODMCoU1	The primary goals of the B. Sc. in Mathematics are to give students a strong foundation in the fundamentals of mathematics and its applications, which are necessary for admission to Master's programs in Mathematics and other related domains.
ODMCoU2	Use and create logical arguments, be knowledgeable about proof methods and how to apply the rules of logic in mathematical proofs, comprehend mathematical concepts clearly and coherently, use computational tools to solve mathematical problems, and construct/use mathematical models to address real-world issues.
ODMCoU3	Offer a set of core courses in Mathematics aimed at developing the students' intellectual curiosity, creative ability and grow habit of independent or collective lifelong learning.
ODMCoU4	Provide the opportunity for the student to participate in research projects, seminars, workshops, conferences, symposium for exchanging knowledge and share innovative ideas.
ODMCoU5	Promote ethics and social values to become a kind and responsible human being.
ODMCoU6	Provide facility for the graduates in problem solving, modeling, analysis, and computations for mathematical exploration in natural, engineering, and biological sciences which essentially lead them to solve real-world problems.
ODMCoU7	Provide opportunities for the student to become technologically expert and participate in collaborative work for developing their leadership and group work skills.

ODMCoU-Objectives of the Department of Mathematics Comilla University

Graduate Attributes

The following graduate attributes encompass the essential skills and qualities of the Department of Mathematics aims to develop in its graduates, equipping them with a solid foundation for further academic pursuits or successful careers in various fields where mathematical expertise is required.

GADMCoU1	**Disciplinary Knowledge:** Exhibiting a profound grasp of mathematical concepts in all the branches of pure and applied mathematics through comprehension of one or more disciplinary knowledge so that graduates are able to conduct further studies in multi-disciplinary or multi-professional environments.
GADMCoU2	**Critical Thinking, Analytical Reasoning and Problem Solving:** Ability to employ critical reasoning and analyze the results for the applications which appear in the different domains in mathematics, especially natural, industrial, engineering and biological sciences.
GADMCoU3	**Research, Innovation and Collaboration:** Graduates will possess proficient cognitive abilities to investigate scientific questions efficiently and solve problems by the use of

	mathematical notions through effective collaborations.
GADMCoU4	**Digital Literacy and Computational Efficiency:** Graduates will be skilled in utilizing computational tools and software to efficiently solve mathematical problems, perform simulations, and analyze data.
GADMCoU5	**Sense of Questioning:** Graduated would be capable of planning, carrying out, and reporting an investigation and asking pertinent and appropriate questions regarding issues and challenges in mathematics.
GADMCoU6	**Professionally Responsible and Ethical Awareness:** Take personal responsibility, and accountability in attaining goals and experience to contribute in a positive, respectful and ethical manner, both personally and professionally.
GADMCoU7	**Global Awareness and Environmental Sustainability:** Thrives to become a citizen of a global village by adapting the interdisciplinary and professional expertise in an international standard. Moreover, updated with technological developments in their own and related fields.

GAMCoU-Graduates Attributes of the Department of Mathematics Comilla University

Program Educational Objectives (PEOs)

The Mathematics department has designed courses for B.Sc. (Honors) degree, reflecting to the goal of preparing students with deepening their subject knowledge and enriching their mathematical skills. The program as well as the teaching methodologies in each curricular unit contribute to this common purpose and to the development of the skills and competences. For bridging the dimensions which are - knowledge & understanding, skills & techniques, competence & capacities - the program educational objectives (PEO) are to-

PEO1	Contribute the fundamental knowledge of mathematics and its applications with the ability of generalization, abstraction, logical reasoning, in particular, to be familiar with techniques.
PEO2	Enhance the knowledge of mathematical results and ability to communicate mathematical ideas and concepts with clarity and coherence.
PEO3	Enrich the ability to formulate and solve problems, including mathematical modeling of real situations for applying in natural, biological and engineering sciences.
PEO4	Develop the competence of analytical and computational skills in solving practical problems using computational tools.
PEO5	Acquire the ability to enhance the engagement in solving new problems and assist them in achieving the essential knowledge needed to carry out research independently and in a team.
PEO6	Improve the student's capacity to apply mathematical and physical principles to guide professional practices and effectively communicate scientific results in written, oral and interactive presentation.
PEO7	Train the student to handle professional and ethical responsibility maintaining research findings and interactive presentations secrecy.
PEO8	Promote the students to take part in various learning sessions, which can be achieved by faculty-directed research student, student-oriented seminars, and other fruitful activities.

Program Learning Outcomes (PLOs)

On the successful completion of the program graduates' will be able to-

PLO1	**Knowledgeable on Mathematics:** Graduates will be utterly familiar with mathematical notions, preliminaries, notations, terminologies, theories, lemmas, postulates, paradoxes,

	principles of mathematics, and problem-solving techniques.
PLO2	**Knowledgeable on Allied Courses:** Graduates will be familiar with allied courses such as Physics, Statistics, Computer Sciences, Information and Commutations Technology, Economics, and other professional courses.
PLO3	**Analyzer:** Students will be able to reasoning the basic principles of mathematics and use them in understanding, analyzing, and developing formal arguments to drive the theories and lemmas.
PLO4	**Connectivity:** Graduates can build connections between the mathematical sciences and other scientific and humanistic disciplines.
PLO5	**Mathematical Modeling:** Graduates can construct mathematical models for real-world problems such as physical, biological, industrial, financial, environmental, engineering, technological and related areas and solve those models efficiently.
PLO6	**Researcher**: Graduate students will be able to create knowledge by learning the processes of scientific research, acquire excellent critical thinking, plan, and design various problems and conduct individual research work to explore findings.
PLO7	**Expert in Computations:** Students will be capable of handling computer-related issues and skilled in different kinds of computing software and programming languages to perform high performance computing.
PLO8	**Communicative:** Graduate students will be able to share ideas, information, and scientific knowledge in both oral and written ways. Moreover, arrange, conduct, interact positively, and present scientific results in seminars, symposiums, workshops, and conferences efficiently.
PLO9	**Applicability:** Graduates will have a predisposition for outreach toward applied areas such as physical, biological engineering, industrial and social sciences, financial service and have the knowledge, experience, and motivation to bring the tools of mathematics and statistics to deals with the real-world problems.
PLO10	**Team Work and Leadership**: Graduates can establish interpersonal relationships and be comfortable working in a team.
PLO11	**Professional Attitude:** Graduates will be keen to demonstrate professional duties, have a positive attitude, control emotions, and take challenges.
PLO12	**Ethical and Accountable**: Students will be able to reveal moral values, social values, accountability, responsibility, professional ethics, academic integrity, and commitment.

Mapping of University Mission with PEOs

Mission/ PEOs	MCoU1	MCoU2	MCoU3	MCoU4
PE01	2	2	2	2
PE02	2	2	2	2
PE03	3	3	2	2
PE04	3	3	2	2
PE05	2	2	3	2
PE06	3	3	3	3
PE07	2	3	2	2
PE08	2	2	3	3

Level of alignment: 3-Significant; 2-Good and 1- Average

Mapping of the Department Mission with PEOs

Mission/ PEOs	DMMCoU1	DMMCoU2	DMMCoU3	DMMCoU4	DMMCoU5	DMMCoU6
PE01	2	2	3	2	2	2

PE02	3	3	3	2	2	2
PE03	2	3	3	3	2	2
PE04	2	3	3	3	2	2
PE05	3	2	2	2	3	3
PE06	2	2	3	3	3	2
PE07	2	2	2	3	2	3
PE08	2	2	2	3	3	3

Level of alignment: 3-Significant; 2-Good and 1- Average

Mapping of PLOs with PEOs

PLOs/ PEOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
PE01	3	1	2	2	2	1	1	2	2	2	1	1
PE02	3	2	3	2	2	2	1	2	2	2	1	1
PE03	2	1	2	2	3	3	1	1	2	1	1	1
PE04	2	2	1	2	1	2	2	1	2	2	1	1
PE05	2	1	2	3	3	2	2	3	2	1	1	1
PE06	2	1	2	3	1	2	2	3	2	2	2	1
PE07	1	1	1	2	1	2	1	3	2	2	2	3
PE08	2	2	3	3	3	3	2	3	3	3	3	2

Level of alignment: 3-Significant; 2-Good and 1- Average

Structure of the Curriculum

Curriculum Structure			
1.	Description of the program	04 Years	08 Semester
2.	Admission Requirements	The applicants having HSC or equivalent degree will be eligible for admission into this program. Other terms and conditions are set or revised periodically by the appropriate authority.	
3.	Graduating Credits / Total Minimum Credit Requirement to Complete the Program	148	
4.	Available Credits	175	
5.	Total Class Weeks in a Term	14	
6.	Minimum CGPA Requirements for Graduation	2.25	
7.	Maximum Academic Years of Completion	06 Years	

Year/Semester Wise Distribution of Course Credit

Year	Semester	Core (Cr.)	Core Lab(Cr.)	Core Viva(Cr.)	GED (Cr.)	GED Lab(Cr.)	Total (Cr.)
First Year	First	9			9		18
	Second	9		2	9		20
Second Year	First	15			3	2	20
	Second	12		2	3	2	19
Third Year	First	9	2		5		16
	Second	15		2		2	19
Fourth Year	First	12	2		2		16
	Second	18		2			20
		99	**4**	**8**	**31**	**6**	**148**

Degree Requirements: Successful Completion of 148 Credits

SL. No.	Courses	Credit
01.	Major Courses (Core+ Core Lab+ Core Viva)	111
02.	GED Courses (GED+ GED Lab)	37
Total Credit (Graduation): 148		
Percentage of GED in the Curriculum	25%	

Semester-wise Distribution of Courses

First Year First Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-111	MTH 111	Fundamentals of Mathematics	Core	03		100	3.0
0541-112	MTH 112	Differential Calculus	Core	03		100	3.0
0541-113	MTH 113	Geometry of Two Dimensions	Core	03		100	3.0
0741-114	CSE 114	Computer Fundamentals	GED	03		100	3.0
0542-115	STA 115	Principles of Statistics	GED	03		100	3.0
0311-116	ECO 116	Principles of Economics	GED	03		100	3.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**18**
			09	**09**	**00**	**0.0**	

First Year Second Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-121	MTH 121	Vector Calculus	Core	03		100	3.0
0541-122	MTH 122	Integral Calculus	Core	03		100	3.0
0541-123	MTH 123	Geometry of Three Dimensions	Core	03		100	3.0
0741-124	CSE 124	Programming with C and C++	GED	03		100	3.0
0542-125	STA 125	Probability and Distributions	GED	03		100	3.0
0533-126	PHY 126	Fundamentals of Physics	GED	03		100	3.0
0541-199	MTH 199	Comprehensive Viva	Core		-	100	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**20**
			09	**09**	**00**	**02**	

Second Year First Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-211	MTH 211	Real Analysis I	Core	03		100	3.0
0541-212	MTH 212	Linear Algebra I	Core	03		100	3.0
0541-213	MTH 213	Numerical Analysis I	Core	03		100	3.0
0541-214	MTH 214	Ordinary Differential Equations I	Core	03		100	3.0
0541-215	MTH 215	Calculus of Several Variables	Core	03		100	3.0
0533-216	PHY 216	Modern Physics	GED	03		100	3.0
0741-217	CSE 217	Programming with C and C++ Lab	GED		02	50	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**20**
			15	**03**	**02**	**0.0**	

Second Year Second Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-221	MTH 221	Real Analysis II	Core	03		100	3.0
0541-222	MTH 222	Linear Algebra II	Core	03		100	3.0
0541-223	MTH 223	Numerical Analysis II	Core	03		100	3.0
0541-224	MTH 224	Ordinary Differential Equations II	Core	03		100	3.0
0541-225	MTH 225	Programming with FORTRAN	GED	03		100	3.0
0541-226	MTH 226	Math Lab-I: Programming with FORTRAN	GED		02	100	2.0
0541-299	MTH 299	Comprehensive Viva	Core	-	-	100	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**19**
			12	**03**	**02**	**02**	

Third Year First Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-311	MTH 311	Complex Analysis I	Core	03		100	3.0
0541-312	MTH 312	Abstract Algebra I	Core	03		100	3.0
0541-313	MTH 313	Partial Differential Equations	Core	03		100	3.0
0541-314	MTH 314	Discrete Mathematics	GED	03		100	3.0
0741-315	CSE 315	Data Structures and Algorithms	GED	02		50	2.0
0741-316	CSE 316	Data Structures and Algorithms Lab	GED		02	50	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**16**
			09	**05**	**2**	**0.0**	

Third Year Second Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-321	MTH 321	Complex Analysis II	Core	03		100	3.0
0541-322	MTH 322	Abstract Algebra II	Core	03		100	3.0
0541-323	MTH 323	Fuzzy Mathematics	Core	03		100	3.0
0541-324	MTH 324	Mathematical Methods	Core	03		100	3.0
0541-325	MTH 325	Theory of Numbers	Core	03		100	3.0
0541-326	MTH 326	Math Lab II: Basic Concept of MATLAB	Core		02	100	2.0
0541-399	MTH 399	Comprehensive Viva	Core	-	-	100	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**19**
			15	**00**	**02**	**02**	

Fourth Year First Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-411	MTH 411	General Topology	Core	03		100	3.0
0541-412	MTH 412	Statics	Core	03		100	3.0
0541-413	MTH 413	Tensor Analysis	Core	03		100	3.0
0541-414	MTH 414	Linear Programming	Core	03		100	3.0
0541-415	MTH 415	Research Methodology	GED	02		50	2.0
0541-416	MTH 416	Math Lab III: Numerical Analysis with MATLAB	Core		02	100	2.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**16**
			12	**02**	**02**	**0.0**	

Fourth Year Second Semester							
ISCED Code	**Course Code**	**Course Title**	**Course Status**	**Contact Hours/W**		**Marks**	**Credits**
				Theory	**Lab**		
0541-421	MTH 421	Functional Analysis	Core	03		100	3.0
0541-422	MTH 422	Dynamics	Core	03		100	3.0
0541-423	MTH 423	Hydrodynamics	Core	03		100	3.0
0541-424	MTH 424	Mathematical Modeling in Biology	Core	03		100	3.0
0541-499	MTH 499	Comprehensive Viva	Core	-	-	100	2.0
Any Two Elective Courses							
0541-425	MTH 425	Measure Theory	Core	03		100	3.0
0541-426	MTH 426	Differential Geometry	Core	03		100	3.0
0541-427	MTH 427	Applied Data Analysis	Core	03		100	3.0
0541-428	MTH 428	Astronomy	Core	03		100	3.0
0541-429	MTH 429	Graph Theory	Core	03		100	3.0
0541-430	MTH 430	Financial Mathematics	Core	03		100	3.0
0541-431	MTH 431	Classical Mechanics	Core	03		100	3.0
0311-432	ECO 432	Econometrics	GED	03		100	3.0
0542-433	STA 433	Bioinformatics	GED	03		100	3.0
0541-450	MTH 450	Honours Project	Core	03		100	3.0
	Total		*Core*	*GED*	*LAB*	*V. Voce*	**20**
			18	**00**	**00**	**02**	

Examination Rules and Regulations for B. Sc. (Honos) Degree

1. Preamble

The rule is named "Examination Rules and Regulations for Bachelor's Degree" of Comilla University. This rule is applicable for Four (4) Years' Bachelor Degree Programme' divided into eight (8) Semesters. The Programme will be operated under semester system and will be guided and assessed according to the credit point system.

2. Medium of Instruction

The medium of instruction of the programme of different academic faculties shall be English/ or Bangla. The Academic Committee of the concerned department shall have the right to decide the medium of instruction.

3. Duration of the Academic Programme

The duration of the Bachelor degree programmes shall be *four* (4) academic years divided into eight (8) semesters. Each academic year is divided into two semesters to be called as 1st semester and 2nd semester.

An academic semester comprised of six months is distributed as follows:

i.	Class Teaching (class)	=	14 weeks
ii.	Preparation time for semester-final examination	=	1 weeks
iii.	Semester-final examination	=	3 weeks
	Total =	**18 Weeks**	

4. Examination Entry Requirements

A student will be allowed to take part in Semester Final Examination if S/he fulfils the following conditions:

a.	**If the student has registered for the concerned semester in due time.**
b.	**If s/he has the required percentage of attendance in each course lecture.**
c.	If the student has paid all dues (registration fees/tuition fees/other charges) applicable to university administration/residential hall administration/ discipline administration.
d.	If the student has not been instructed by the Disciplinary Board / Examination Disciplinary Committee to refrain from taking part in the examination.

5. Duration of the Final Examination

The final examination for every one or two credit point theoretical course shall be of 2-hour duration, and the courses having more than two credit point theoretical course shall be of 3-hour duration. The duration of the practical examination shall be four to six hours as the concerned Department decides.

6. **Penalty for the Adoption of Unfair Means**

A student who has adopted unfair means in any examination, assignment, term papers, reports, research monograph etc., might be expelled from that semester, or any other punishment might be imposed on him/her by the Examination Disciplinary Committee. Each such case has to be reported to the Examination Disciplinary Committee by the chief invigilator through the chairman of the Examination Committee. The Instruction to the examinee on the cover leaf of the answer script must be followed by the examinee. Violation of these instructions and/or any clause under Section-4 of the "Rules and Regulation Regarding Examination Offences and Disciplinary Actions" (Annes-2) will be treated as a serious offence and punishable.

7. **Evaluation System**

a. Theoretical Course: Each theoretical course offered should be composed of either 50 or 100 marks (each 50 marks course consisting of 2 credit points). The proportion of the total marks of a particular course shall be distributed as follows:

Continuous Assessment / Before-Final Assessment	= 40%
Semester-Final Examination	= 60%
Total = 100%	

b. **Continuous Assessment:** Marks allocated for before-final assessment shall be distributed as follows:

i. Internal Evaluation

i.	Mid-Semester Examination (at least two mid-semester exams.)	20%
ii.	Presentation	10%
iii.	Class Test and/or Quiz and/or In-course and-or Sudden test and-or tutorial and/or Case study and-or practical and-or Field work Assignment	5%
iv.	Attendance	5%
Total = 40%		

ii. Class Attendance: The marks allocated for class attendance shall given as following proportions:

Attendance	Marks
90% and above	100%
85% to less than 90%	90%
80% to less than 85%	80%
75% to less than 80%	70%
70% to less than 75%	60%
65% to less than 70%	50%
60% to less than 65%	40%
Less than 60%	00%

iii. Before-final Assessment Report

At the end of the course, the course teacher shall calculate the total marks of the continuous assessment (including class attendance) and prepare a marks sheet. The answer scripts of the mid-term examinations should be shown to the students as it is valuable for their learning process. The before-final assessment marks have to be submitted to the Controller of the Examinations before the suspension of class for the semester final examinations.

The course teacher shall also submit the class attendance marks along with the register/documents to the Chairman of the Department. The chairman will take into consideration the attendance mark while forwarding the examination entry forms to the Controller of the Examinations.

iv. Class Attendance Requirement to Appear in the Semester Final Examination

Suppose the class attendance of any student at any course is below 60%, but in the range of 40% to 59%. In that case, s/he will be allowed to attend the examination only with the recommendation of the course teacher and the approval of the department's chairman. Hence, the student will have to pay a fine as fixed by the authority/department.

A student with a class attendance of less than 40% in any course will be debarred from appearing in the Final Examination.

v. *Letter Grade and Grade Point*

Total marks obtained in each course, oral (viva-voce) examination and practical courses shall be converted into LG (Letter Grade) and GP (Grade point) as follows:

Numerical Grade	Letter Grade		Grade point	Interpretation
80% and above	A+	(A Plus)	4.00	Outstanding
75% to less than 80%	A	(A regular)	3.75	Excellent
70% to less than 75%	A-	(A minus)	3.50	Very Good
65% to less than 70%	B+	(B Plus)	3.25	Good
60% to less than 65%	B	(B regular)	3.00	Satisfactory
55% to less than 60%	B-	(B minus)	2.75	Below Satisfactory
50% to less than 55%	C+	(C Plus)	2.50	Average
45% to less than 50%	C	(C regular)	2.25	Pass
40% to less than 45%	D	.....	2.00	Poor
Less than 40%	F	.....	0.00	Fail

8. Registering Complaints about Marking, Grading and Related Issues

No complain shall be accepted on final marking, grading and related issues. Correction on before-final assessment can be made by the concerned course teacher if s/he finds justifiable ground to correct and that must be done before submission of before-final assessment marks to the Controller of Examinations.

9. Promotion

a. **Keeping consistency with the spirit of the semester system, the semester-wise promotion will be declared.**

b. **For promotion from one semester to the next semester, a student is required to earn minimum 50% of the total credit in the respective semester on condition that s/he has passed the viva-voce. The remaining Credit hour has to earn within next available batches.* The failed student shall be allowed to appear in the examination only in the fail course/s, and no need to appear the course/s that already passed except improvement. In calculating, 50% of the total credit number of courses will be counted to avoid fractions. For example, 50% of 15 credit courses will be counted 09 credits; rather than 7.5 credits (If there are five courses 03 credit each)**

c. If anybody is absent form the viva-voce on any valid ground a viva-voce may be arranged for him/her on condition that s/he will bear all expenses of the viva. In such case s/he has to apply to chairman of the department within 15 days after the viva-voce exam.

10. Degree Requirements

a. For B.Sc. (Honours) degree degree, a student requires to

i. Earn required number of total credit points successfully.

ii. Earn a minimum CGPA of 2.25.

iii. Complete the programme within six academic years from her/his 1st admission to the program.

b. Award of (Pass) Degree

i. **A student who fails to secure a minimum CGPA of 2.25 after completing eighth semester final examination but succeeds in securing a CGPA between 2.00 and 2.25 will be eligible for a Pass Degree.**

ii. A student who fails to remove 'F' in any two courses but secure a minimum CGPA of 2.00 after completing eight semester final examination will be eligible for a pass degree

iii. The student with a Pass Degree shall not be eligible for admission into Masters Program

11. Improvement/F-removal of Grades

i. **F-removal:** A student having earned 'F' grade in any course in any semester shall be required to remove the 'F' grade. Removal of 'F' grade in any course is permitted only for two (2) times excluding the regular examination which has to be done with subsequent available batches

ii. **Improvement:** A student having earned letter grade **'B-' (GP- 2.75)** or below in any course may be allowed to improve the grade by appearing in the semester-final examination with the next available batch. S/he can avail this opportunity only once for a course. In such case the best GPA from the improvement or the regular examination of the concern subject shall be calculated for tabulation

iii. **No improvement shall be allowed in 7th & 8th semester.**

iv. For appearing in the improvement examination, a student shall have to pay fees for the course prescribed for the purpose.

v. A student willing to improve grade should apply to the controller of examination through the chairman of the department within 01 (one) week after the publication of the results of the semester.

vi. No improvement shall be allowed in continuous assessment (mid-term/class-test/assignment/ fieldwork/ monograph/ project/ practical/case-study/term-paper/quiz test/etc.).

vii. Special Semester Exam: Students who did not get the opportunity of removing 'F' in any course as per rule 12 (i) shall be allowed to sit for a special semester examination. This will be allowed only for the courses in 7th and 8th semester. In special cases this opportunity would be allowed for courses in semester 5th and 6th. In such cases student have to apply to the Chairman of the department within one week after publication of the 8th semester result. The Chairman of the department shall take necessary administrative measures for arranging the special semester examinations by the respective 4th year examinations committee. All the expenses relating to this examination shall be borne by the candidate(s).

viii. **If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.**

ix. If a student gets one month after his result publication to sit for the examination with a batch that batch will be considered as available batch for her/his.

12. Re-admission

i. A student failing to earn the requisite credit points for promotion (clause 10) from one semester to the next may seek readmission with the following batch.

ii. **For readmission a student shall have to apply within one month after the announcement of the result of the concerned semester.**

iii. Readmitted student shall be allowed to appear in the examination only in the fail course/s and no need to appear the course/s that already passed except improvement

13. Drop-out

i. If a student re-admitted twice in any semester fails to earn minimum required credits for promotion shall be dropped out from the programme.

ii. **If a student fails to earn required total credit points within six academic years since admissions, s/he will be dropped-out from the programme and will no more be allowed to continue his/her studentship with other programmes.**

14. Credit Transfer

No Credit transfer from any other programmes /University /Institutions to the Comilla University is allowed.

Detailed OBE Curriculum

B.Sc. (Honours) in Mathematics

Session: 2024-2025, 2025-2026, 2026-2027

First Year First Semester

Course Title	Fundamentals of Mathematics	**ISCED Code**	0541-111
		Course Code	MTH 111
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Fundamentals of Mathematics is a major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the understanding of Fundamentals of Mathematics.

Rationale

Fundamentals of Mathematics are the foundations of all mathematics courses. Understanding this course will precede everyone to learn other areas of mathematics. After completing this course, students will get some useful and applicable ideas on set theory, relations and functions with graphs, inequalities, theory of equations algebraic series, complex number system, plane trigonometry.

Course Objectives

Fundamental of Mathematics is a partially non-calculator introductory mathematics course which covers mathematical skills relevant to degrees requiring a basic level of mathematical knowledge and ability. The course learning includes but is not limited to an understanding of basic concepts, set theory, relations, functions. The students will also learn about arithmetic and geometric series, mathematical induction, the concept of the Complex Number System, inequalities, the theory of equations and trigonometry**.**

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Know the basic properties of the natural numbers, rational numbers and real numbers.
CLO2	Develop knowledge about the set theory in real world andmake comparison between sets.
CLO3	Illustrate the various types relations and functions.
CLO4	Be familiar with different types ofinequalities and Demonstrate and apply the theory of mathematical induction.
CLO5	Explain the De Mover's theorem tosolve several equations and Evalute trigonometric series and hyperbolic functions.

Course Contents

	Course Contents	Hours	**CLOs**
1.	**Basic Concepts:** Sets, Subsets, Set operations, Family of sets, De Morgan's laws, Venn diagram, Empty set and Universal set, Relations and Functions.	8 Hrs.	CLO1, CLO2,CLO4
2.	**Inequalities:** Number systems, Field and order properties of real numbers, Average mean, Arithmetic mean, Geometric mean, Weierstras's Inequality, Cauchy-Schwarz Inequality, Tchebychef's and Holder's inequality.	8Hrs.	CLO1, CLO2, CLO3, CLO5
3.	**Theory of Equations:** Equations and identities, Basic ideas of solution of equations with graphical representations, Relation	9 Hrs.	CLO2, CLO3, CLO4, CLO5

	between roots and coefficients of the nth degree equations, Synthetic division, Descarte's rule of signs, Newton's method, Reciprocal equations and Sturm's theorem, Position of roots, Multiplicity of roots, symmetricity of roots, Transformation of equation.		
4.	**Series:** Basic definition of series, Techniques of summing up series, Tests for convergence and divergence of series (with less emphasis on proofs of theorems), Method of difference, Successive difference method.	9 Hrs.	CLO4, CLO5,
5.	**Plane Trigonometry**: Complex number system, Argand's diagram, Forms of complex numbers, De Moiver's theorem and its applications, Complex variable, Circular functions and inverse circular functions of complex quantities. Exponential series for complex quantity, Euler's exponential values, Hyperbolic functions, Summation of trigonometric series: method of difference, *C+iS* method. Power series, Logarithmic series, Gregory's series, Expansion of series.	8 Hrs.	CL04, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦		♦	-	-	-	-	-	-	-	-	-
CLO3	-	-	-	-	-	♦	-	-	-	-	-	-
CLO4	♦	-	♦	♦	-	♦	♦	-	-	-	-	-
CLO5	♦	♦	♦	-	-	♦	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Barnard. S, Child, J. M.**, Higher Algebra, *Macmillan And Company Limited*, 1936.
ii.	**Loney S. L.**, Plane Trigonometry, *Arihant Publication India Limited*, 2018.

Supplementary Readings

i.	**Swokowski E. W.,** Calculus with Analytic Geometry, *Prindle, Weber & Schmidt,* 1983.
ii.	**Lipschutz S**., Set Theory and Related Topic, *McGRAW-HillPublishing Company*, 1964.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Visual Presentation	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing, Student Activity and Discussion	Midterm (Summative)
CLO5	Lecturing and Discussion	Presentation and Final Exam (Summative)

Course Title	Differential Calculus	**ISCED Code**	0541-112
		Course Code	MTH 112
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Differential Calculus is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, assignments, two midterms and comprehensive examinations.

Rationale

Calculus is one of the most fundamental courses in mathematics which majorly contains two parts, one is **Differential Calculus** and other is integral calculus. Generally, the part of calculus concerned with finding tangent lines and rates of change is called differential calculus. The course mainly contains the initial part of differential calculus (single variable function). Understanding this course will lead everyone to learn the other mathematical courses which need the fundamentals of differentiation.

Course Objectives

Differential Calculus for functions of one variable including a study of limits, continuity, derivatives of different classes of functions, maxima and minima, concavity, related rates and optimization problems. In this course, the students will be able to find the rate at which one quantity changes relative to another.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Articulate various elementary functions both algebraically and graphically.
CLO2	Illustrate the graph of the equation which follows function or inverse function.
CLO3	Achieves curve sketching techniques.
CLO4	Evaluate limits, derivatives, limits in indeterminate form and Identify the end behavior of a function and continuity of various types of functions.
CLO5	Analyze increasing, decreasing functions and find maxima and minima, critical points and inflection points of functions and to determine the concavity of curves and Apply the application of differentiation in real-world problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**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, Compositions of functions, Inverse functions.	9 Hrs.	CLO1, CLO2, CLO3, CLO5,
2.	**Limit and Continuity:** Definitions and basic theorems on limit and continuity, Limit at infinity and infinite limits with computation.	7 Hrs.	CLO4, CLO5
3.	**Derivatives:** Tangent lines and rates of change, Definition of derivative, One-sided derivatives, Rules of differentiation of various functions (proofs and applications), The product and	8 Hrs.	CLO4, CLO5

	quotient rules, The chain rule, Implicit differentiation, Related rates, Linear approximations and differentials.		
4.	**Successive Differentiation:** Higher order derivatives, Leibnitz's theorem and its applications.	6 Hrs.	CLO4, CLO5
5.	**Applications:** a) Tangent and normal (for both Cartesian and Polar curves). b) Rolle's Theorem, Mean value theorem. c) Increasing and decreasing functions, Concavity and points of inflection, Saddle points. d) Maximum and minimum values of functions, Absolute maximum and minimum values of functions, Optimization problems. e) Asymptotes, curvature and envelopes.	8 Hrs.	CLO4, CLO5,
6.	**Indeterminate forms:** L' Hospital's rules.	4 Hrs.	CLO4

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	-	-	-	-	-	♦	-	-	-	-
CLO3	♦	♦	♦	-	-	-	-	♦	-	-	-	-
CLO4	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO5	♦	♦	♦	-	-	-	-	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Anton, H., Bivens, I.C. and Davis, S.,** *Calculus*. Tenth Edition, John Wiley & Sons, 2021.
ii.	**Thomas J., George B., Maurice D. Weir, Joel H., and Christopher H.,***Thomas' calculus*. Fourteenth Edition, Boston, Pearson, 2018.

Supplementary Readings

i.	**Swokcoski E. W.,** *Calculus with Analytic Geometry*, Prindle, Weber & Schmidt, 1983.
ii.	**Stewart J.,** *Calculus*, Cengage Learning, 2015.

Teaching-Learning and AssessmentStrategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Geometry of Two Dimensions	**ISCED Code**	0541-113
		Course Code	MTH 113
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Geometry of Two Dimensions is a major/compulsory/core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of functional analysis.

Rationale

Geometry of Two Dimensions combines numbers and shapes. In algebra, we have first, second and higher-order equations, which have geometrical shapes. The geometrical problem can be solved by algebra, and the algebraic problem can be solved by geometry. So geometrical conception is essential for mathematics students.

Course Objectives

Upon completion of this course, students will be able to develop a comprehensive understanding of the concepts of two-dimensional geometry. They will learn about axes, translation and rotation of axes, conics, and conic sections for two-dimensional functions. This course seeks to provide students with a deeper understanding of relationships in spaces as well as in the plane. In addition, it provides the ability to perform deductive proof in mathematical situations.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Recognize co-ordinate and its translation and rotation system and evaluate conic.
CLO2	Illustrate point, line, mid-point, distance and vector in two-dimensional space.
CLO3	Articulate the equation of straight lines, circle and conic and their properties.
CLO4	Sketch graphs and discuss relevant features of lines, circles and conic sections and Analyze the different consequences and meanings of parallelism on the Euclidean and hyperbolic planes.
CLO5	Demonstrate knowledge of the historical development of Euclidean and non-Euclidean geometries and Apply acquired pieces of knowledge for solving problems in measurement of length and area in any shape in a plane.

Course Contents

Course Contents		**Hours**	**CLOs**
1.	Coordinate Systems: Transformation of coordinates, Translation and rotation of axes, Invariants.	14 Hrs.	CLO1, CLO2,CLO3, CLO4& CLO5
2.	Pair of straight lines (homogeneous second degree equations, general equation of second degree representing pair of straight lines).	14 Hrs.	CLO2, CLO3, CLO4 & CLO5
3.	General equations of second degree, Conics (circle, parabola, ellipse, hyperbola: reduction to standard forms, identifications, properties and tracing of conics).	14 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO4	♦	♦	♦	♦	-	♦	♦	-	-	-	-	-
CLO5	♦	-	♦	-	-	♦	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Swokcoski E. W.,** *Calculus with Analytic Geometry*, Prindle, Weber & Schmidt, 1983.
ii.	**Thomas Jr. B. G., and Finney L. R.,** Calculus with Analytic Geometry, *Addison andWesley,* 1986.

Supplementary Readings

i.	**LoneyS.,** Elements of Coordinate Geometry,*University of Michigan Libra*, 1899.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative), Midterm and Final Exam (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Presentation (Formative) and Final Exam (Summative)

Course Title	Computer Fundamentals	**ISCED Code**	0741-114
		Course Code	CSE 114
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Computer Fundamentals is a compulsory GED course for the students of the B.Sc. (Honours) program. The course carries **3.0 credits** and **42 hours** of effective class teaching. Teaching techniques consist of traditional lectures, including question-answer sessions and discussions, tests/quizzes over lecture materials, etc.

Rationale

With digitization permeating various aspects of our lives, computers have become omnipresent. They can be found everywhere, from educational institutions such as schools and colleges to essential services like banks and post offices, as well as in the professional world. Universities, in particular, make extensive use of computers. One notable example is Google Classroom, which facilitates online course instruction and allows students to access and utilize it remotely. Additionally, many of our daily tasks are now performed on computers. **Computer Fundamentals** is a prominent GED course that focuses on the fundamental aspects of computer usage. It is specifically designed for newly admitted students with little to no prior computer experience. This course aims to provide an understanding of computer hardware, software, and relevant terminology, all essential knowledge for mathematics students.

Course Objectives

The main objective of **Computer Fundamentals** is to give theoretical knowledge of how a computer works. It provides introductory concepts of different applications of terms and programs. The course further prepares students for future laboratory-oriented courses.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Analyze the basic parts of computer system, types of computer, history and generations of computers, number system and basic digital circuits.
CLO2	Distinguish about hardware, software and operating system.
CLO3	Classify the Computer networks.
CLO4	Formulate the simple computer programs.

Course Contents

	Course Contents	Hours	CLOs
1.	**General Featuresof a Computer**: General features of a computer, Generation of computers, Personal computer, Workstation, Mainframe computer and super computers. Computer applications–data processing, Information processing, Commercial, Office automation, Industry and engineering, Healthcare, Education, Graphics and multimedia.	6 Hrs.	CLO1
2.	**Computer Organization and Peripheral Devices:** Computer organization, Central processing unit, Computer memory–primary memory and secondary memory, Secondary storage devices–Magnetic and optical media, Input and output units, OMR, OCR, MICR, Scanner, Mouse and Modem.	6 Hrs.	CLO1

3.	**Computer Hardware and Software:** Computer hardware and software, Machine language and high-level language, Application software, Computer program, operating system, Computer virus, Antivirus and computer security.	6 Hrs.	CLO1 CLO2, CLO3
4.	**Computer Arithmetic and Number System:** Computer arithmetic, Binary, Octal and hexadecimal number systems, Additive method of subtraction, 1's complement, 2's complement, Subtraction using 1's and 2's complement.	6 Hrs.	CLO1 CLO2, CLO 3
5.	**Logic Gates:** Algorithm and flowcharts, Illustrations, Elements of a database and its applications, Basic Gates (De Morgan's theorems, duality theorem, NOR, NAND, XOR, XNOR gates), Boolean expressions and logic diagrams, Types of Boolean expressions.	6 Hrs.	CLO1 CLO2, CLO3, CLO4
6.	**Programming Concepts**: Algorithm, Pseudo code, Problem analysis, Structured programming languages: Overview of C, Data types, Variables, Constants, Operators, Expressions control structures, Arrays and String.	6 Hrs.	CLO1, CLO2, CLO3, CLO4
7.	**Introduction to Networking:** Network of computers. Types of networks, LAN, Intranet and Internet, Internet applications, World Wide Web, E-mail, Browsing and searching, Search engines, Multimedia applications.	6 Hrs.	CLO1, CLO2, CLO3, CLO4

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	♦	-	♦	-	-	♦	-
CLO2	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	-	♦
CLO3	♦	♦	-	♦	-	♦	-	-	-	-	♦	_
CLO4	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Sinha P. K.,** Computer fundamentals, *BPA Pub*., 2004.
ii.	**Norton P.,** Introduction to computers, *McGraw Hill*, 2006.

Supplementary Readings

i.	**Rajaraman V.,** Fundamentals of Computers, *Prentice Hall India Pvt.*, 2004.
ii.	**Subramanian N.**, Introduction to computers, *McGraw Hill*, 2001.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Students Activity and Group Discussion	Quiz/ Homework (Formative), Misterm and Midterm (Summative)
CLO2	Lecturing and Presentation	Assignment (Formative) and Midterm and Final Exam
CLO3	Lecturing, Discussion and Discussion	Presentation (Formative), Midterm and Final Exam (Summative)
CLO4	Lecturing and Group Discussion	Quiz/Homework, Presentation (Formative), Midterm and Final Exam (Summative)

Course Title	Principles of Statistics	**ISCED Code**	0542-115
		Course Code	STA 115
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Principles of Statistics is a GED compulsory course for the undergraduate students of the B.Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, assignments, two midterms and comprehensive examinations. This is a fundamental course for the theory and applications of statistics. It requires successful completion of **Algebra and Calculus.**

Rationale

Principles of Statistics is designed to provide fundamental statistical concepts and some of their practical application in mathematics. The course aims to shape the attitudes and concentration of learners regarding the field of Statistics.

Course Objectives

Principles of Statistics will enable students to understand, interpret and undertake descriptive statistics analysis. Students will also able to understand basic concepts in probability theory, properties of probability operators and characteristics of random distributions. It will be easy and simple to understand, undertake and interpret point, interval estimation and hypothesis testing for the students. Also, this course aims to explain the Ordinary Least Squares estimation method and interpret regression analysis results.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Decipher the background of statisticsand its scopes,applications.
CLO2	Identify the relevant population, sample, study units (subjects), variables, and data. Also Produce and interpret graphical summaries of data and based ongraphical displays, describe basic characteristics of the data distribution.
CLO3	Calculate and interpret numerical summary statistics as well as to have knowledge of important properties of different measurements and Summarize relationships in vicariate data using graphical, tabular, and numerical methods including scatter plots, two-way tables.
CLO4	Identify linearity, non-linearity, and outliers, and describe their impact on a simple linear regression model (ordinary least squares) and on the correlation Coefficient.
CLO5	Use a simple linear regression model to predict the value of one variable based on the value of an associated variable and Calculate and interpret the correlation between two variables. Finally, Make out needs of Life table, there construction and applications.

Course Contents

	Curse Contents	Hours	CLOs
1.	**Introduction:** Definition of statistics, Its nature and scope, Nature of statistical data, Attributes and Variables, Population and sample.	6 Hrs.	CLO1, CLO2
2.	**Data Collection and Representation**: Classification of data, Frequency distribution and Graphical representation of data.	4 Hrs.	CLO2, CLO3
3.	**Measure of Location**: Definition of measure of location, Arithmetic Mean, Geometric Mean, Harmonic Mean, Median and Mode, Important properties of measure of location. Merits, Demerits and applications.	7 Hrs.	CLO1, CLO2, CLO3
4.	**Measure of Dispersion**: Definition, Difference of absolute and relative measures, Properties of Mean deviation, Variance and S. D. Merits, Demerits and applications.	5 Hrs.	CLO1, CLO2, CL03 , CLO4

5.	**Moments, Skewness and Kurtosis**: Definition of moments, Skewness, Kurtosis, Properties of the measures, Relationship between skewness and kurtosis, Shape and Nature of the measures.	6 Hrs.	CLO3, CLO4
6.	**Correlation and Regression**: Definition and Difference of correlation and regression, Check Origin and scale on the measures, Properties and uses of the measures, Least square methods and Rank Correlation.	6 Hrs.	CLO4, CLO5
7.	**Index Number**: Definition and classification of Index number, Construction of index Number. T.R.T. and F.R.T., and Ideal index number.	4 Hrs.	CLO4, CLO5
8.	**Time Series Analysis**: Detailed study of time series analysis, Component of time series, Evaluation of trend and Applications of time series analysis.	4 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOsv

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	♦	-	-	-	-
CLO2	♦	-	-	-	-	-	-	-	-	-	-	-
CLO3	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	-	♦	-	♦	♦	-	♦	-	-	-	-
CLO5	♦	♦	♦	-	♦	♦	-	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Hoel P. G.,** Introduction to Mathematical Statistics, *Wiley,* 1984.
ii.	**Hogg R. V., and Craig A. T.,** Introduction to Mathematical Statistics, *Pearson,* 2012.
iii.	**Mosteller F., Rourke S. E., and Fienberg R. E. K.,** Beginning Statistics with Data Analysis, *Dover publications,* 2013.

Supplementary Readings

i.	**Mostofa M. G.,** Methods of Statistics, Brothers publications, 2016.
ii.	**Islam M. N.,** An Introduction to Statistics and Probability, *Mullick and Brothers,* 2022.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative) and Midterm (Summative)
CLO2	Lecturing and Discussion	Midterm and Final Exam (Summative)
CLO3	Lecturing and Visual Presentation	Assignment, Presentation (Formative), Midterm and Final Exam (Summative)
CLO4	Lecturing and Group Discussion	Homework (Formative) and Final Exam (Summative)
CLO5	Lecturing, Discussion and Question Answering	Quiz (Formative), Midterm and Final Exam (Summative)

Course Title	Principles of Economics	**ISCED Code**	0311-116
		Course Code	ECO 116
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Principles of Economics is a compulsory GED course for undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42** hours of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for basic knowledge in **Economics.**

Rationale

Understanding the Principles of Economics has immense importance for scientifically solving resource allocation problems. By conducting this course, students will be acquainted with a thorough grounding in the basic principles of economics and an exposure to arrange of applications of the theory in real-world problems.

Course Objectives

The course's primary objective is to acquaint students with the basic concepts of microeconomics and macroeconomics. This course analyzes various economic policies and how they affect economic fluctuations and foster economic growth and development.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Explain the key ideas that define the economic way of thinking as mathematician and policy advisers.
CLO2	Understand to a range of micro and macroeconomic issues.
CLO3	Recognize the functions of money, central bank and commercial bank.
CLO4	Demonstrate substantial knowledge on fundamental economic question of allocating scarce resources, principles of demand, supply, market price and quantity determination.
CLO5	Construct the knowledge of how consumers make choices and understand the production theory and firm behavior.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction**: Definition and scope of economics, Basic concepts and tools used in economics, Economic problems, Scarcity and Resources.	3 Hrs.	CLO1
2.	**Demand and Supply:** Concept of demand and supply, Law of demand and supply, Determinants of demand and supply, Demand and supply functions, Equations, Schedules and curves, Market equilibrium, Price, income, Cross and supply elasticity.	6 Hrs.	CLO 2, CLO 4
3.	**Economics of Consumer Behavior:** Utility analysis, Paradox of value, Law of diminishing marginal utility, Indifference curve analysis, Budget constraints, Consumers equilibrium, Change in income and prices, Derivation of demand curves, Income and substitution effects, and Consumers surplus.	6 Hrs.	CLO 2, CLO 5
4.	**Economics of Firm-Production and Costs**: Production function, Law of diminishing return, Stage of production, Law of variable proportion, Short run and long run production and costs.	3 Hrs.	CLO5
5.	**Introduction to Macroeconomics:** Definition, Macro-economic performance, Measuring national product and national income – GNP, NNP, NI, Personal disposable income, Nominal and Real GNP, Circular flow of income, and Value added.	6 Hrs.	CLO 3, CLO 4

6.	**Determination of National Income:** Concepts of aggregate demand and planned spending, Aggregate supply, Equilibrium output / income, Change in equilibrium output, and Multiplier.	6 Hrs.	CLO 4, CLO5
7.	**Money and Banking:** Definition and functions of money, Different kinds of money, Banking – Goldsmith banking, Commercial bank and the money stocks, Functions of central bank, Money supply, Open market operations, and High powered money.	6 Hrs.	CLO 4, CLO5
8.	**Bangladesh Economy:** Overview of the economy of Bangladesh, Major sectors of the economy and their contribution to national income, GDP growth, Export and import items, Balance of trade, Balance of payment, Unemployment, and Inflation.	6 Hrs.	CLO 4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	♦	♦	♦	♦	-	♦	-	-	♦	-	-
CLO2	-	♦	-	♦	♦	-	-	♦		♦	-	-
CLO3	♦	♦	-	♦	-	-	-	♦	-	-	-	-
CLO4	♦	♦	-	♦	-	-	-	-	-	♦	-	-
CLO5	-	♦	-	-	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Samuelson P., and Nordhaus W.D.,** Economics, *19th Edition, McGraw Hill,* 2010.
ii.	**Baumol W. J., and Blinder, A.,** Economics: Principles and Policy, *Harcourt Brace Jovanovich,* 2008.

Supplementary Readings

i	**Parkin M.,** Microeconomics, 6th Edition, *Addision Wesley,* 2005.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Students Activity, Discussion	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

First Year Second Semester

Course Title	Vector Calculus	**ISCED Code**	0541-121
		Course Code	MTH 121
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus and Geometry	**Total Marks**	100

Course Description

Vector Calculus is a major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for the applied mathematics study and research. However, it requires successfully completion of **Calculus and Geometry** courses.

Rationale

Vector Calculus is a fundamental area of mathematics essential in many fields of science and engineering, including physics, electrical engineering, computer graphics, and many others. It is a powerful tool for describing and analyzing physical systems with both magnitude and direction, such as force, velocity, and electric and magnetic fields. This Vector Calculs course is designed to provide students with a deep understanding of vector calculus, including vector fields, line integrals, surface integrals, and the fundamental theorems of calculus. Through the course, students will develop the skills to apply vector analysis for solving real-world problems in science, engineering, and mathematics problems.

Course Objectives

Usually, Vector Calculus studies vector algebra, scalars, basic concept about product of vectors, vector valued functions of several variables, concepts of limit continuity, differentiability total derivatives, and partial derivatives. Moreover, the course gives strong intuitions on the flow mechanism related to the vector operators, like gradient, divergence and curl. On the other hand, students can familiar with single, double and triple integrals interms of unit normal vectors. Vector calculus provides strong understanding about the related integral theorems and curvilinear coordinates. Nowadays, vector calculus is regarded as not only a part of applied mathematics, but also the most important part of mathematical analysis. This course offers students both an opportunity for systematic learning of vectors and its applications and an introduction to advanced courses such as continuum mechanics, fluid dynamics, and electromagnetics.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts and fundamental principles of vector analysis.
CLO2	Perform the basic algebra operation of vectors and Calculate limit and examine the continuity and differentiability of several variables.
CLO3	Determine the product of vectors and apply this concept in algebraic and trigonometric aspect, illustrate the partial derivatives and determine the directional derivatives and Find the divergence and curl of a vector and prove identities involvingthese.
CLO4	Estimate the length, surface area and volume through double and triple integrals and Understand the various integral theorems relating line, surface and volumeintegrals.
CLO5	Study the vector operators in terms of different coordinate systems and Apply vector algebra as a tool in applied sciences and related fields such as, continuum mechanics, fluid mechanics, geosciences, electromagnetic theory and so on.

Course Contents

	Curse Contents	Hours	CLOs
1.	**Vector Differentiation:** Vector valued function, Continuity, Differentiability, Partial derivatives of vector valued function and Differential geometry.	6 Hrs.	CLO1, CLO2, CLO3, CLO4
2.	**Gradient, Divergence and Curl:** Introductory concepts and intuitions of vector operators, Gradient, Divergence, Curl, Related formulas and Invariance.	6 Hrs.	CLO2, CLO3
3.	**Vector Integration:** Concepts of ordinary integration and Vector valued function, Basic Techniques of Finding Double and Triple Integration, Line integrals, Surface integrals and Volume integrals.	10 Hrs.	CLO3, CLO4
4.	**Integral Theorems**: Introductory concepts, Greens theorem, Divergence theorem and Stokes theorem.	8 Hrs.	CLO4, CLO5
5.	**Curvilinear Coordinates:** General curvilinear co-ordinates, Orthogonal curvilinear co-ordinates, Spherical polar co-ordinates, Cylindrical co-ordinates etc., Differential operators in general curvilinear co-ordinates and Orthogonal curvilinear co-ordinates; Line, Surface and Volume elements in curvilinear co-ordinates.	12 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	-	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	♦	-	♦	-	-	-	♦	-	-	-
CLO3	♦	♦	♦	-	♦	♦	-	-	♦	♦	-	-
CLO4	♦	-	♦	-	-	♦	-	-	-	-	-	-
CLO5	♦	-	♦	-	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Spiegel M. R., Lipschutz S., and Spellman D.,** Vector Analysis, *McGraw Hill,* 2009.
ii.	**Chatterjee U., and Chatterjee N.,** Vector and Tensor Analysis**,** *Academic Publishers,* 2014.

Supplementary Readings

i.	**Raisinghania M. D.,** Vector Calculus*, S. Chand & Co.,* 1997.
ii.	**Khanna M. L.,** Vector Analysis, *Generic,* 1997.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Student Activity	Midterm (Summative)
CLO3	Lecturing and Group Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Integral Calculus	**ISCED Code**	0541-122
		Course Code	MTH 122
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Algebra, Geometry and Trigonometry	**Total Marks**	100

Course Description

Integral Calculus is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, assignments, two midterms and comprehensive examinations. This is an introductory course for the theory and applications of integration. It requires successful completion of **Algebra, Geometry and Trigonometry**.

Rationale

Integral calculus is a branch of calculus concerned with the theory and applications of integration. In Mathematics, integration is a method of adding or summing up the parts to find the whole. It is a reverse process of differentiation, where we reduce the functions into parts. Integral calculus is used for calculations involving arc length, pressure, area, the centre of mass, volume, and work. Calculus can also help more precisely comprehend the nature of space, time, and motion.

Course Objectives

The **Integral Calculus** course aims to provide a firm foundation in the concepts and techniques of integrations. It is primarily concerned with developing the student's understanding of anti-derivative concepts and providing experience with its methods and applications. It emphasizes 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 interest and provide the kind of problem-solving experience that the students might find in a research or industrial setting.

Course Learning Outcomes (CLOs

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Illustrate the concepts of anti-derivatives and indefinite integrals learn different techniques of evaluating integration.
CLO2	Learn to understand differentiation and anti-differentiation as inverse operation and Realize the meaning of the definite integral both as a limit of Riemann sums and as the area under a curve.
CLO3	Demonstrate basic properties of integration, evaluation of integration by successive reduction and Develop and apply definite integrals to evaluate area between two curves, volumes of solids of revolution, surface area, arc lengths utilizing different methods.
CLO4	Draw diagrams in polar coordinates, find tangent curves, evaluate areas enclosed by polar curves and arc lengths of the curves and Test convergence and divergence of different series, understand the different types of improper integrals and solve them.
CLO5	Evaluate some special integrals applying gamma and beta functions and Apply the method of integration to real-life problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Indefinite Integrals**: Introduction to indefinite integrals as anti-derivatives, Changes of variables in indefinite integrals, Standard formulae, Techniques of integration, Integration by parts and integration of trigonometric functions and rational functions.	7 Hrs.	CLO1, CLO2
2.	**Definite Integrals**: Concept of definite integration, Definite integration as the limit of a sum (with equally spaced as well as unequal intervals), Properties of definite integrals and their applications.	6 Hrs.	CLO2, CLO3

3.	**Theorems:** Fundamental theorems of integral calculus.	4 Hrs.	CLO1, CLO2 CLO3
4.	**Reduction formulae:** Reduction formulae for both indefinite and definite integrals.	5 Hrs.	CLO1, CLO2, CL03, CLO4
5.	**Applications of Definite Integrals**: Curve tracing, Arc length, Plane areas, Volumes of solids of revolutions, Volumes by cylindrical shells, Volumes by cross-sections and area of a surface of revolution (for both Cartesian and polar curves).	6 Hrs.	CLO3, CLO5
6.	**Graphing in Polar Coordinates and Applications**: Curve tracing, Tangents to polar curves, Areas enclosed by curves in polar coordinates and arc length in polar coordinates.	5 Hrs.	CLO1, CLO3, CLO4
7.	**Improper Integrals**: Definition and evaluation of improper integrals, Tests for convergence and their applications.	5 Hrs.	CLO1, CLO3 CLO5
8.	**Gamma and Beta:** Gamma and Beta functions with applications.	4 Hrs.	CLO4 , CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO 1	PL02	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	♦	-	-	-	-
CLO2	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	♦	♦	-	♦	♦	-	♦	-	-	-	-
CLO5	♦	-	-	-	♦	♦	-	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Anton, H., Bivens, I.C. and Davis, S.,** *Calculus*. Tenth Edition, John Wiley & Sons, 2021.
ii.	**Thomas J., George B., Maurice D. Weir, Joel H., Christopher H.,***Thomas' calculus.* Fourteenth Edition, Boston, Pearson, 2018.

Supplementary Readings

i.	**Swokcoski E. W.,** *Calculus with Analytic Geometry*, Prindle, Weber & Schmidt, 1983.
ii.	**Stewart J.,** *Calculus*, Cengage Learning, 2015.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Midterm and Final Exam (Summative)

Course Title	Geometry of Three Dimensions	**ISCED Code**	0541-123
		Course Code	MTH 123
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Fundamentals of Mathematica, Calculus and Geometry of Two-Dimensions.	**Total Marks**	100

Course Description

Geometry of Three Dimensions is a major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks.** The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of functional analysis. However, it requires successful completion of **Fundamentals of Mathematics, Basic Algebra, Calculus and Geometry of Two-Dimensions** courses.

Rationale

Geometry of Three Dimensions is a branch of algebra combining numbers and shapes to model three-dimensional objects. In algebra, we have 1st, 2nd and higher-order equations with a three-dimensional shape. Geometric problems can be solved by algebra, and algebraic problems can be solved by geometry. Therefore, the geometric concept is essential for mathematics students. Geometrically, one studies the Euclidean plane and Euclidean space. Solid geometry is essential because it establishes a correspondence between mathematical curves and algebraic equations. This correspondence makes it possible to reformulate problems in geometry as equivalent problems in Algebra and vice versa; the methods of each subject can then be used to solve problems in other subjects.

Course Objectives

To provide students with a comprehensive understanding of the concepts of three-dimensional geometry and demonstrate geometric relationships in the plane as well as in space. Students will learn about three-dimensional coordinates, conics (sphere, cone, cylinder, paraboloid, ellipsoid, hyperboloid) and demonstrate the ability to feel geometrically three-faceted shapes.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Illustrate the rectangular, cylindrical and spherical co-ordinates and theirtranslation.
CLO2	Articulate the concept on plane, straight line, shortest distance and directioncosine. Identification of conicoid i.e., sphere, cone, cylinder, paraboloid, ellipsoid, hyperploid and their properties anduses.
CLO3	Compare and contrast the geometries of the Euclidean and hyperbolic planes and Analyze axioms for the Euclidean and hyperbolic planes and their consequences
CLO4	Analyze the different consequences and meanings of parallelism on the Euclidean and hyperbolic planes and demonstrate knowledge of the historical development of Euclidean and non-Euclidean geometries.
CLO5	Use concrete models to demonstrate geometric concepts and Apply dynamical geometry software for constructions and testing conjectures.

Course Contents

	Course Contents	Hours	CLOs
1.	Three Dimensional coordinates, Distance between two points, Section formula, Direction cosines and direction ratios of a straight line.	8 Hrs.	CLO1, CLO2
2.	Plane (Equations of planes, Angle between two planes, Distance of a point from a plane).	10 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5
3.	Straight line (Equations of lines, Relationship between planes and lines, Shortest distance between two straight lines).	12 Hrs.	CLO1, CLO3
4.	General equation of second degree, conicoids (sphere, paraboloid, ellipsoid, hyperboloid: reduction to standard forms, identifications of conicoids, basic properties)	12 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO3	♦	-	♦	♦	-	-	-	♦	-	♦	-	-
CLO4	♦	♦	♦	♦	-	♦	-	-	-	-	-	-
CLO5	♦	-	♦	-	-	♦	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings:

i.	**Swokowski E. W.,** Calculus with Analytic Geometry, *Prindle, Weber & Schmidt,* 1983.
ii.	**Thomas G. B. Jr., and Finney R. L.,** Calculus with Analytic Geometry, *Addison Wesley*, 1986.

Supplementary Readings

i.	**Loney. S.,** Analytic Geometry,*University of Michigan Libra*, 1899.
ii.	**Hummel J. A.,** Vector Geometry, *Addison-Wesley Pub. Co.,* 1965.
iii.	**Lang S.,** A First Course in Calculus, *Columbia University,* 1964.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Presentation and Final Exam (Summative)

Course Title	Programming with C and C++	**ISCED Code**	0741-124
		Course Code	CSE 124
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Fundamentals of Computer	**Total Marks**	100

Course Description

Programming with C and C++ is a compulsory course for the students of the B.Sc. (Honours) program. The course carries **3.0 credits** and **42 hours** of effective class teaching. Teaching techniques consist of traditional lectures, which include question-answer sessions and discussions, tests/quizzes over lecture materials, etc. Prerequisite for taking this course is the successful completion of **Fundamentals of Computer**.

Rationale

Computer science is all about solving problems with computers. The problems we want to solve can come from any real-world problem or perhaps even the abstract world. Computer programming is at the heart of computer science. It is the implementation portion of software development, application development and software engineering efforts, transforming ideas and theories into actual, working solutions. The primary purpose of this course is to teach students the basics of pure programming and problem-solving. This course provides students with a comprehensive study of the C and C++ programming languages. The course emphasizes problem-solving and empirical skills through the process of designing, implementing, and executing C and C++ programs.

Course Objectives

The main objectives of **Programming with C and C++** is to understand the complete knowledge of C programming and gain knowledge and experience about structured programming. It helps students to develop programming skills to solve different problems. The course further prepares students to understand and implement various concepts and structures of C and C++ programming languages.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Demonstrate problem-solving skills by developing and implementing algorithms to solve problems.
CLO2	Analyze the basic programming concepts: constants, variables, expressions, data types, and operators in formulation of mathematical models.
CLO3	Evaluate the design programs involving decision structures, loops and functions, array, string, and pointers.
CLO4	Assemble the design of the program with union, structures and manipulate basic data files.

Course Contents

	Course Contents	Hours	CLOs
1.	**Problem Solving Techniques:** Problem analysis, Algorithm, Flowchart, Debugging, Coding and Documentation.	15 Hrs.	CLO1, CLO2, CLO3, CLO4
2.	**Structured Programming Language:** Overview of C, Data types, Variables, Constants, Operators, Expressions, Control structures, Functions and program structure, Parameter passing conventions, Scope rules and Storage classes, Recursion, Header files, Pre-processor, Pointers and arrays, Strings, Multidimensional array,	27 Hrs.	CLO1, CLO2, CLO 3, CLO4

	User defined data types, Structures, Unions, Enumerations, Input and Output, Standard input and output, Formatted input and output, File access, Variable length argument list, Command line parameters, Error Handling, Graphics, Linking, and Library functions.		

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	♦	-	♦	-	-	♦	-
CLO2	♦	♦	-	♦	-	♦	♦	♦	-	♦	-	♦
CLO3	♦	-	♦	-	-	♦	-	-	-	-	♦	_
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Ritchie D.**, The C programming language. *Prentice Hall,* 1988.
ii.	**Balagurusamy E.**, Programming in ANSI C, *McGraw Hill*, 2017.
iii.	**Herbert S.,** Teach Yourself C, *Osborne McGraw Hill*, 1990.

Supplementary Readings

i.	**Stephen G. K.,** Programming in C, *Addison-Wesley Professional,* 2014.
ii.	**Dromey R.G.,** How to solve it using Computer, *Prentice Hall,* 1985.
iii.	**King K. N.,** C Programming- A Modern Approach*, W. W. Norton,* 2008.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)

Course Title	Probability and Distributions	**ISCED Code**	0542-125
		Course Code	STA 125
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Algebra, Calculus and Set Theory	**Total Marks**	100

Course Description

Probability and Distributions is a compulsory GED course for undergraduate students of the B.Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, assignments, two midterms and comprehensive examinations. This is a fundamental course for learning the theory and applications of probability and distribution. It requires successful completion of **Algebra, Calculus and Set Theory.**

Rationale

Probability and Distributions is a continuation of Introductory Statistics. This course is designed to provide the basic concept of probability distribution. This course also describes the basic sampling technique and statistical hypothesis testing to test data validity.

Course Objectives

Theory and practices of statistical analysis and inference with emphasis on analyzing and solving real problems using statistical methods like Probability and Distributions. Descriptive statistics, topics from probability, sampling distributions, estimation, hypotheses testing, regression, correlation, nonparametric techniques and analysis of variance, and computer programming are incorporated throughout.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Turn data into information.
CLO2	Collect and use sample data and evaluate complicated probabilities.
CLO3	Evaluate sampling distribution and employ confidence intervals to guide decisions
CLO4	Test hypotheses and evaluate significance in research reports and Sample and use the population regression models.
CLO5	Perform computer simulation for analysis of variance.

Course Contents

	Course Contents	Hours	CLOs
1.	**Sampling:** Sample space, Events, Union and intersection of events combinatory, Probability of events, Frequency of limit of probability, Addition law of probability , Conditional probability, Multiplication law of probability, Bayes theorem, Statistical independence, Repeated trials, Dependent and independent trials, Additive and Multiplicative law of probability.	9 Hrs.	CLO1, CLO2, CLO3
2.	**Random Variable and Mathematical Expectation:** Definition and classification of random variable, Probability function, probability density function, Joint and marginal probability function and probability density function, Mathematical expectation, variances, Additive and Multiplicative rule of expectation.	8 Hrs.	CLO1, CLO2 , CLO3

3.	**Study of Probability Distributions:** Basic study of Binomial, Poisson and Normal Distribution.	5 Hrs.	CLO1, CLO3, CLO4
4.	**Demography:** Definition, Nature and scope of Demography, Sources of demographic data, Survey and census and Measurement of population growth with special reference of Bangladesh.	6 Hrs.	CLO2, CL04, CLO5
5.	**Fertility and Reproduction:** Concept of fertility of reproduction, Measurement of fertility, Mortality, and Standardized death rate by direct and indirect method.	7 Hrs.	CLO3 , CLO5
6.	**Life Table:** Definition, construction of life table, classification and functional relationship of life table and Applications of life table.	7 Hrs.	CLO1, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	♦	-	-	-	-
CLO2	♦	-	-	-	-	-	-	-	-	-	-	-
CLO3	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	-	♦	-	♦	♦	-	♦	-	-	-	-
CLO5	♦	♦	♦	-	♦	♦	-	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Fellor W.,**Introduction to Probability, *Wiley,* 1968.
ii.	**Mosteller F., Rourke S. E., and Fienberg R. E. K.,** Beginning Statistics with Data Analysis, *Dover publications,* 2013.
iii.	**Vijay K. R.,** An Introduction to Probability and Statistics, *Wiley,* 2015.

Supplementary Readings

i.	**Islam M. N.,** An Introduction to Statistics and Probability, *Mullick and Brothers,* 2022.
ii.	**Roy M. K.,** Fundamentals of Probability and Probability Distributions, *ROMAX publications,* 2019.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Presentation and Final Exam (Summative)

Course Title	Fundamentals of Physics	**ISCED Code**	0533-126
		Course Code	PHY 126
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Basic Concept on Physics, Basic Algebra, Calculus	**Total Marks**	100

Course Description

Fundamentals of Physics is an introductory physics course which is a compulsory GED course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course to understand modern physics. However, it requires successful completion of **Fundamentals of Mathematics, Basic Concept on Physics, Calculus and Geometry.**

Rationale

Fundamentals of Physics will provide experiences for the student that will lead him/her to understand the basics of physics and nature and combine some basic integration, differentiation, and discussion of differential equations with nature.

Course Objectives

Upon completing this course, Students will learn about vectors, space and time, kinematics, forces, energy and momentum, conservation laws, rotational motion, torques, simple harmonic motion and sound waves and their applications.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand about vectors, space and time, kinematics, forces, energy.
CLO2	Understand momentum, conservation laws, rotational motion, and torques and Classify the different forms of energy and use the conservation of energy to work problems
CLO3	Analyze impulse, momentum andcollisions and identify and describe fluids in motion and at rest.
CLO4	Elasticity and moduli of elasticity and Identify and explain the notions of sound and sound waves and also Conduct measurements of sound andnoise.
CLO5	Explain simple harmonic motion and waves including theirproperties and Clear concept about Compound and Keter's pendulum.

Course Contents

	Course Contents	Hours	CLOs
1.	**Vector Analysis:** Definitions, Vector dot and cross product of two vectors, Triple product, Gradient, Divergence, Curl and their Physical significance.	6 Hrs.	CLO1 ,CLO2
2.	**Conservation of Energy and Linear Momentum:** Conservative forces and system, Conservative of energy and linear momentum, Center of mass, Collision problem.	4 Hrs.	CLO1, CLO2, CLO3, CLO4
3.	**Rotational Motions:** Rotational variables, Torque, moment of inertia, Angular momentum, Parallel axes theory perpendicular axes of inertia, Combined translational and rotational motion of rigid body, and Conservation of angular momentum.	8 Hrs.	CLO2, CLO3, CLO4 , CLO5

4.	**Gravitation:** Center of gravity of extended bodies, Gravitational field and potential and their calculations Determination of gravitation constant and gravity.	5 Hrs.	CLO2, CLO4, CLO5
5.	**Elasticity:** Moduli of elasticity, Poison's ratios, Relations between elastic constants and their determination, Cantilever, Flat spiral spring.	4 Hrs.	CLO5
6.	**Simple Harmonic Motions:** Simple harmonic motion, Lisqjous figures, Combination of harmonic motions, Damped harmonic motion, Forced oscillation and resonance.	4 Hrs.	CLO2, CLO5,
7.	**Wave in Elastic Media:** Types of waves, Superposition principle, Wave velocity, Power and intensity in wave motion, Interference of waves, Complex waves, Standing waves and resonance.	6 Hrs.	CLO4, CLO5
8.	**Sound Waves:** Audible, Ultrasonic and infrasonic waves, Propagation and speed of longitudinal waves, Vibrating systems, Source of sound, Beats, Doppler effect acoustics, Sabina's formula.	3 Hrs.	CLO4, CLO5
9.	Velocity; Compound and Keter's pendulum	2 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO3	-	-	♦	-	-	♦	-	♦	-	-	-	-
CLO4	♦	-	♦	-	-	-	-	-	-	♦	-	-
CLO5	♦	♦	♦	♦	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Holliday D., and Resnic R.,** Physics (part-1), *John Wiley &Sons Inc*,1977.
ii.	**Spigel M. R.**, Theory and problems of vector Analysis, *McGraw-Hill*, 1959.
iii.	**Halliday D., Kran K. S., and Resnick R.,** Physics, *John Wiley & Sons,* 2005.

Supplementary Readings

i.	**Newman F. W. and Searle V. H. L.,** General Properties of Matter, *Edward Arnold and Co. London,* 1929.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm (Summative)
CLO5	Lecturing and Discussion	Presentation and Final Exam (Summative)

Course Title	Comprehensive Viva	**ISCED Code**	0541-199
		Course Code	MTH 199
Course Type	Core	**Course Status**	Oral/Presentation
Course Hour	---	**Credit Value**	2.0
Prerequisite	Recommended Books and Lecture Materials	**Total Marks**	100

Course Description

Comprehensive Viva is a major/compulsory/core course for undergraduate students of B. Sc. Students pursue a **2.0 credit** (Honors) program, requiring effective teaching in the first and second semesters. Course grades will be assessed through participation, class presentations, quizzes, and comprehensive examinations. However, it requires successful completion of all courses in the first and second semesters.

Rationale

Yearly Comprehensive viva gives students the opportunity to demonstrate their understanding of the subject and answer questions.

Course Objectives

This is a platform to practice and show their smartness and confidence, as well as to address immediate issues in the society.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Realize themselves through oral assessment that helps students develop valuable communication skills.
CLO2	Enable interactive dialogue between candidate and assessor, allowing the examinee to demonstrate strengths and letting examiners discriminate between superficial and real knowledge via in-depth questioning.
CLO3	Have the ability to tailor the questions asked to the needs of each individual.
CLO4	Assess on the spot. Recent years have seen this traditional form of assessment used mostly to defend different subjects.
CLO5	In order to discriminate among the top achieving students, higher order cognitive skills can be tested by in-depth questioning.

Course Contents

	Course Contents	Duration	CLOs
1.	Students respond orally to questions during the comprehensive viva examination. These tests frequently draw from both the first and second semesters' worth of coursework. A vital component of academic programs, viva exams are frequently administered at the end of each academic year.	First and Second Semester	CLO1, CLO2, CLO3, CLO4, CLO5
2.	These Viva examinations formed part of the theory component of the final summative examination in the second semester of the first year. Since the Viva Voce is conducted for all students irrespective of their passing status in theory, the exercise is time consuming. To determine the impact of viva voce examinations on summative examination performance, this study has been conducted.		
3.	The main focus of the assessment is on the written/		

	thesis/dissertation (and other outputs, for a Practice as Research students) in communicative English, basic computer knowledge, physics, statistics, algebra, geometry in two dimensions and differential calculus. Since mathematics is a fundamental subject, job-seeking students should investigate it at many organizations in the labor market. Viva voce is necessary to make mathematics appealing to the business and research fields.		

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	♦	-	♦	-	-	-	-
CLO2	♦	♦	♦	♦	-	-	-	-	-	-	-	-
CLO3	-	♦	-	♦	-	♦	♦	♦	♦	-	♦	-
CLO4	-	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦
CLO5	-	-	♦	-	-	-	-	-	♦	♦	♦	-

♦: Aligned -: Not-aligned

Learning Material

Recommended Readings

i.	All the recommended books of First Year 1st and 2nd semester.

Teaching Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1-CLO5	Student Activity	Presentation, concept and understanding on the taught courses, communication skills, Smartness and Confidence.

Second Year First Semester

Course Title	Real Analysis I	**ISCED Code**	0541-211
		Course Code	MTH 211
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus, Set Theory, Basic Algebra, and Geometry	**Total Marks**	100

Course Description

Real Analysis I is a major, compulsory and core course for undergraduate students in the B. Sc. (Honours) program. It carries **3.0 credits** and **42 hours** of effective teaching over **14 weeks**. Course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This course is an introductory course to advanced analysis. However, it requires **Calculus, Set Theory, Basic Algebra, Abstract Algebra, Linear Algebra, and Geometry**.

Rationale

Real Analysis I is a branch of mathematics that studies the properties of real numbers and their functions. It is concerned with understanding the behavior of functions and sequences of real numbers, including limits, continuity, differentiation, integration, and infinite series. The rationale behind this course is to provide a rigorous foundation for calculus, which studies rates of change and accumulation. It provides a precise framework for understanding the fundamental concepts of calculus, including limits, derivatives, and integrals. It also establishes theorems and principles essential to studying many other areas of mathematics, such as topology, functional analysis, and differential equations.

Course Objectives

One of the main objectives of this course is to establish theorems and principles that are true for all real numbers. This is achieved through the use of axioms and logical reasoning, which allow mathematicians to prove theorems based on a small set of basic assumptions. This course is characterized by its rigorous approach to mathematics, with proofs that are often complex and require a deep understanding of mathematical concepts. This course is also relevant in other fields outside of mathematics, including physics, engineering, and economics. Calculus is often used to solve various issues in science and engineering. This course provides a strong foundation for understanding the concepts used in these fields.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Illustrate the fundamental properties of real numbers that facilitate the formal development of real analysis.
CLO2	Teach students the fundamentals of topology, which are used in limits, continuity, and convergence.
CLO3	Comprehend the properties of metric spaces, which are used in geography and navigation to calculate distances between points on the Earth's surface.
CLO4	Apply properties of real sequences, including their convergence and limits, which are used in the model, and analyze various statistical phenomena, such as time series data and probability distributions and Understand the concepts of an infinite series of real numbers, including convergence tests and absolute convergence.
CLO5	Learn geometric series, which are used to calculate the present and future value of financial investments, annuities, and loans. This series can also analyze and optimize algorithms and data structures in computer science and acquire the concept of power series, which is used to solve differential equations with polynomial coefficients.

Course Contents

	Course Contents	Hours	CLOs
1.	**Real Numbers as Complete Ordered Fields:** Bounded sets, Supremum Principle, Infimum Principle, Completeness axiom and Dedekind's theorem with their equivalence, Archimedean property, Countable and uncountable sets, Denseness of rational and irrational numbers.	9 Hrs.	CLO1
2.	**Topology of Real Line:** Neighborhoods, Open and closed sets, Limit/cluster points and Bolzano-Weierstrass theorem, Interior, Boundary and closure, Derived sets, Compact sets, Hiene-Borel theorem, and Connected sets.	9 Hrs.	CLO2 ,CLO3
3.	**Real Sequences:** Definition of sequence, Bounded sequence, Convergence of a sequence, Null sequence, Theorems on limits of sequences, Sub-sequential limits, Bolzano-Weierstrass theorem for sequences, Cauchy's general principle of convergence, Cauchy's theorems on limits of sequences, Limit superior and limit inferior, Monotone sequence and its convergence, Cauchy sequence and Absolute convergence.	9 Hrs.	CLO4
4.	**Infinite Series of Real Numbers:** Convergence and the sum of infinite series, Cauchy's general principle of convergence, Series of positive terms, Alternating series, Absolute convergence, Tests for convergence (Comparison test, root test, ratio test, integral test, Raabe's test, Gauss's test, Liebnitz's test, Abel's test, Dirichlet's test, etc.), Rearrangements.	9 Hrs.	CLO4 ,CLO5
5.	**Uniform Convergence:** Interchangeability of limiting processes, Power Series.	6 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	♦	-	♦	♦	♦	-	♦
CLO3	♦	♦	♦	♦	-	♦	-	♦	♦	♦	-	-
CLO4	♦	♦	♦	♦	♦	♦	-	-	-		-	-
CLO5	♦	♦	♦	♦	-	-	-	♦	♦	♦	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

ii.	**Sharma J. N., and Batishta A. R.,** Real Analysis, *Krishna Prakashan Media,* 2014.
iv.	**Ross K. A.,** Elementary Analysis: The Theory of Calculus, *Springer,* 2013.

Supplementary Readings

i.	**Chatterjee D.,** Real Analysis, *PHI Learning,* 2012
ii.	**Bartle R. G., and Sherbert D.,** Introduction to Real Analysis, *Wiley,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Presentation
CLO2	Lecturing and Discussion	Mid-Semester and Summative
CLO3	Lecturing and Student Activity	Mid-Semester and Summative
CLO4	Student Activity and Discussion	Presentation
CLO5	Lecturing and Group Discussion	Summative Exam

Course Title	Linear Algebra I	**ISCED Code**	0541-212
		Course Code	MTH 212
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Linear Algebra I is one of the most basic and major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course that blends the theoretical (pure) and computational (applied) study of Mathematics.

Rationale

Linear Algebra I is the introductory course that combines theoretical and applied (computational) aspects of Mathematics. The algorithms/techniques in linear algebra are the fundamental tools having numerous applications in many areas of science and engineering, including computer science, data science, sparse modelling and compressed sensing, signal processing, biophysics, chemistry, medicine, psychology, economics, business studies, environmental sciences, and many other fields. The study of linear algebra aids us in understanding the properties of high-dimensional geometry motivated by the properties in two and three dimensions. This course is designed to give an overview of linear algebra, including the topics of vectors in Rn and Cn, vector spaces, basis and dimension and, linear transformation, solving large systems of equations. Solving a system of linear equations is crucially important to physicists, engineers and scientists to model and solve many physical systems. Operations and supply chain modelling require lots of optimization and mathematical programming, which extensively uses large matrices. For these reasons, this course is a core course for students pursuing a major in mathematics.

Course Objectives

This course aims to give basic concepts of arithmetic operations on vectors and matrices, including the vectors in Rn and Cn, to the students. The students will be competent to solve systems of linear equations and apply these techniques to real-world problems. They will learn to perform matrix algebra, compute determinants and know their properties. They will also learn about and work with vector spaces, subspaces, basis and dimensions, and linear transformations. Students will know the basic terminology of linear algebra in Euclidean spaces, including linear independence, spanning, basis, rank, nullity, and finding and using the eigenvalues and eigenvectors of a matrix to apply problems. The definite integral from calculus will be revisited and recognized as an inner product. The student will understand the concepts of orthogonality of vectors and its use in projecting vectors into subspaces and decomposing vectors into components. Understand the axiomatic structure of a modern mathematical subject and learn to construct simple proofs. Learn the typical applications of Linear Algebra, possibly including Markov chains, areas and volumes, Cramer's rule, the adjoint, and the least squares method. Using some software, the students will have computational proficiency involving procedures in Linear Algebra.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Define vector spaces and perform basic operations on vectors including the vectors in Rn and Cn and define different types of matrices and determinants. Perform basic operations with matrices and find the transpose and inverse of a matrix. Row-reduce a matrix to either row-echelon or reduced row-echelon form.

CLO2	Calculate determinants using row operations, column operations and expansion down any column and across any row and solve systems of linear equations and homogeneous systems of linear equations by Gaussian elimination and Gauss-Jordan elimination.
CLO3	Use matrix operations to solve systems of equations and be able to determine the nature of the solutions. Understand some applications of systems of linear equations and Recognize the concepts of the terms linear combinations of vectors, linear span, linear independence and dependence.
CLO4	Calculate eigenvalues and their corresponding eigenspaces with their applications
CLO5	Describe the kernel, range, rank, and nullity of a linear transformation including their properties. Understand the concept of a linear transformation as a mapping from one vector space to another and be able to calculate its matrix representation with respect to standard and nonstandard bases.

Course Contents

	Course Contents	Hours	CLOs
1.	**Vectors in R^n and C^n:** Review of geometric vectors in R^2 and C^2 space. Vectors in R^n and C^n. Inner product, norm and distance in R^n and C^n.	3 Hrs.	CLO1
2.	**Matrices and Determinants:**Definition of matrix, Different types of matrices, Laws of matrix algebra; Determinant and its properties; Minors and Cofactors, Expansion and evaluation of determinants, Cramer's rule, Adjoint matrix, Invertible matrices and their inverses with applications; Matrix operations, Elementary row or column operations; Echelon forms of matrices, Block matrices, Row rank and column rank of a matrix and their equivalence.	8 Hrs.	CLO2, CLO3, CLO 5
3.	**System of Linear Equations:** Introduction to system of linear equations; Solutions of the system of linear equations (homogeneous and non-homogeneous); Implementation of matrix operations and determinants to solve the system of linear equations and identify the nature of the solutions.	9 Hrs.	CLO4, CLO5
4.	**Vector Spaces:** Basics of groups and fields with their properties, Vector space, Subspaces, Linear combinations of vectors, Linear independence and dependence of vectors, Linear span, Basis and dimension of vector spaces, Solution spaces of systems of linear equations, Row space, Column space, Null space.	8 Hrs.	CLO4, CLO5
5.	**Linear Transformations:** Linear transformation, Kernel and image of linear transformation and their properties, Rank and nullity of linear transformation, Matrix representation of linear transformation.	6 Hrs.	CLO4, CLO5
6.	**Eigenvalues and Eigenvectors:**Definition of eigenvalues and eigenvectors with their properties, Characteristic equation, Cayley-Hamilton theorem, Diagonalization of matrices and their applications.	8 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	♦	-	♦	-	-	-	-	-	-	-
CLO2	♦	♦	♦	-	♦	-	-	-	-	-	-	-
CLO3	♦	♦	♦	♦	♦	-	-	-	-	-	-	-
CLO4	♦	-	♦	♦	♦	-	-	-	-	-	-	-
CLO5	♦	-	♦	♦	♦	-	-	-	♦	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Anton H. and Rorres C.,** Elementary Linear Algebra: Applications Version, *John Wiley & Sons*, 2013.
ii.	**Lipschutz S.,** Linear Algebra, 9th Edition, *McGraw-Hill*, 2019.

Supplementary Readings

i.	**Strang G.,** Linear Algebra and its Applications, Belmont, CA: Thomson, *Brooks/Cole*, 2006.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz and Assignment
CLO2	Lecturing and Discussion	Mid-Semester and Summative
CLO3	Lecturing and Discussion	Mid-Semester and Summative
CLO4	Student Activity and Discussion	Summative Exam
CLO5	Lecturing and Discussion	Presentation, Assignment and Summative Exam

Course Title	Numerical Analysis I	**ISCED Code**	0541-213
		Course Code	MTH 213
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./week	**Credit Value**	3.0
Prerequisite	Real analysis, Calculus and Linear Algebra	**Total Marks**	100

Course Description

Numerical Analysis I is one of the most basic and major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. On the other hand **Numerical Analysis I** is the area of mathematics that creates, analyzes, and implements algorithms for solving numerically the problems of continuous mathematics. Such problems originate generally from real-world applications of algebra, geometry and calculus, and they involve variables which vary continuously; these problems occur throughout the natural sciences, social sciences, engineering, medicine, and business.

Rationale

Numerical Analysis I is the study of algorithms that use numerical approximation for the problems of analysis. Numerical analysis continues this long tradition of practical mathematical calculations. 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 engineering and the physical sciences.

Numerical Analysis I providesstudentswithagoodunderstandingofthe concept and methods ofNumericalanalysis, described in detail in the syllabus. Students will learn about solution techniques of calculus, algebraic equation, systems oflinear equations etc.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand task oriented techniques/ methods for obtaining best approximate solutions and present accurate and robust algorithms for writing computer codes for solving different type of mathematical as well as engineering problems.
CLO2	Improve the existing methods and algorithms andanalyze and estimate the accuracy of common numerical methods.
CLO3	Explain a derivative at a value by using an appropriate numerical method and use different methods of numerical rules for an integral estimate.
CLO4	Find the numerical solution of a system of linear equations by various iterative methods and find out the real life applications of this course and the construction of FORTRAN, MATHEMATICA and MATLAB programs for numerical solutions.
CL05	Develop a number of algorithms and codes which they can apply as a reliable tool in later subjects and projects.

Course Contents

	Course Contents	Hours	CLOs
1.	**Solution of Equation in One Variable**: Error estimate, Bisection method, Method of false position, Fixed point iteration, Newton-Raphson method, Error analysis for iterative method, Accelerating limit of convergence.	12 Hrs.	CLO1, CLO2, CLO3,

2.	**Interpolation and Polynomial Approximation:** Taylor polynomials, Interpolation, Lagrange's interpolations and Divided difference interpolation, iterated interpolation, Central difference interpolation formula and extrapolation.	12 Hrs.	CLO1, CLO2, CLO4
3.	**Differentiation and Integration:** Numerical differentiation, Richardson's extrapolation, Numerical integration, Trapezoidal rule, Simpson's rules, Weddle's rule, Adaptive quadrature method, Romberg's integration and Gaussian quadrature.	9 Hrs.	CLO1, CLO2, CLO5
4.	**Solutions of Linear Systems:** Gaussian elimination and backward substitution, Linear algebra and matrix inversion, Determinant of a matrix, Pivoting strategies, Direct factorization of matrices and LU decomposition method.	9 Hrs.	CLO1, CLO2, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦		♦	-	♦	♦	♦	-	♦	-	♦	♦
CLO2	♦	♦	♦	♦	♦	-	♦	♦	♦	♦	♦	♦
CLO3	♦	♦	-	♦	♦	-	♦	-	-	-	-	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	-	-	-	-
CLO5	♦	♦	♦	♦	♦	♦	♦	-	-	-	-	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Burden R. L. and Faires J. D.,** Numerical Analysis, *Brooks/Cole*, 2011.
ii.	**Sastry S. S.,** Introductory Methods of Numerical Analysis, *Prentice-Hall of India*, 2008.
iii.	**Otto S. R. and Denier J. P.,** An Introduction to Programming and Numerical Methods in MATLAB, *Springer*, 2005.

Supplementary Readings

i.	**Phillips G. M. and Taylor P. J.**, Theory and Applications of Numerical Analysis, *Academic Press*,2006.
ii.	**Gerald C. F. and Wheatley P. O.,** Applied Numerical Analysis, *Pearson*, 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Student Activity and Group Discussion	Homework/Quiz , Mid-Semester and Summative Exam
CLO2	Lecturing, Student Activity and Group Discussion	Homework/Quiz , Mid-Semester and Summative Exam
CLO3	Lecturing, Student Activity and Group Discussion	Homework/Quiz , Mid-Semester and Summative Exam
CLO4	Lecturing	Presentation and Summative Exam
CLO5	Lecturing	Presentation, Mid-Semester and Summative Exam

Course Title	Ordinary Differential Equations I	**ISCED Code**	0541-214
		Course Code	MTH 214
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus and Geometry	**Total Marks**	100

Course Description

Ordinary Differential Equations I is a fundamental course that is required for undergraduate students in the B. Sc. (Honors) program. It carries **3.0 credits** and consists of **42 hours** of effective teaching over **14 weeks**. The assessment for this course includes participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This course is essential as it combines theoretical and computational aspects of studying mathematics.

Rationale

Ordinary Differential Equations I is a fundamental course that explores the theory and applications of ordinary differential equations (ODEs). Through this course, students will develop a deep understanding of ODEs, their classifications, and solution methods. The course emphasizes the mathematical modelling of real-world problems, allowing students to apply ODEs to various fields such as engineering, physics, and biology. Students will learn classical techniques for solving ODEs, including separation of variables, integrating factors, and power series solutions. By the end of the course, students will have the skills to classify ODEs, solve them using appropriate methods, and interpret the solutions in the context of practical scenarios. Ordinary Differential Equations I provides a solid foundation for further studies in advanced mathematics and applied sciences.

Course Objectives

The course **Ordinary Differential Equations I** aims to provide students with a solid foundation in ordinary differential equations (ODEs) and equip them with the necessary skills to solve and analyze these equations in various contexts. Throughout the course, students will develop the ability to derive ODE models from physical descriptions, understand the concepts of initial value problems and their solutions, and identify the types of differential equations and apply appropriate analytical techniques for their solutions. They will learn to solve ODEs with both constant and variable coefficients and explore the practical applications of ODEs in fields such as Biology, Chemistry, Economics, Engineering, and Physics. By the end of the course, students will have a strong understanding of ODEs, enabling them to model real-world problems and make connections between mathematical concepts and their physical interpretations, thereby enhancing their critical thinking and problem-solving skills in a mathematical framework.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO 1	Understand the fundamental concepts of differential equations, including order, degree, linearity, homogeneity, existence and uniqueness theorem.
CLO 2	Apply various solution techniques to solve different kinds of differential equations, both with and without initial conditions, and draw the solutions curves graphically using direction fields.
CLO 3	Identify and categorize first-order differential equations as separable, homogeneous, linear, exact, Bernoulli's, Riccati, and Clairaut's equations. Apply suitable methods to solve these equations effectively and Analyze higher order differential equations, particularly, second order ODE, and classify them as homogeneous or nonhomogeneous.
CLO 4	Apply techniques like reduction of order, method of undetermined coefficients, variation of parameters, and Cauchy-Euler equations to solve higher order differential equations and Determine the linear dependence or independence of a set of functions by definition and by

	utilizing the Wronskian, understanding the concepts of linear dependence and the implications for solutions of differential equations.
CLO 5	Analyze real-world problems from various disciplines, such as Biology, Chemistry, Economics, Engineering, and Physics, by formulating and solving first and second-order differential equations, demonstrating the ability to model and interpret real-world phenomena mathematically.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction to Differential Equations:**Overview of differential equations and their classifications based on order, Linearity and homogeneity, Solutions of differential equations, Explicit, Implicit and singular solutions, Initial value problems, Boundary value problems, Basic existence and uniqueness theorems (conceptual understanding and illustration only), Introduction to direction fields and phase plane analysis.	8 Hrs.	CLO1, CLO2
2.	**Solution Techniques for First-order Equations**: Separable equations, Linear equations, Exact equations, Integrating factors, Substitutions and transformations, Homogeneous equations, Bernoulli equation, Ricatti equation and Clairaut's equation.	10 Hrs.	CLO3
3.	**Modelling with First-order Differential Equations**: Significance of differential equations in modeling natural phenomena, Construction of differential equations as mathematical models (e.g., exponential growth and decay, Heating and cooling, Mixture of solutions, Series circuit, Logistic growth, Chemical reaction, Falling bodies), Interpreting and analyzing model solutions in the context of real-world applications, Orthogonal and oblique trajectories with their significance in modeling.	8 Hrs.	CLO4 , CLO5
4.	**Solution Techniques for Higher Order Linear Differential Equations**: Linear differential operators, Basic theory of linear differential equations, Solution space of homogeneous linear equations, Fundamental solutions of homogeneous equations, Reduction of order, Homogeneous and Non-homogeneous linear equations with constant coefficients, Method of undetermined coefficients, Variation of parameters, Inverse operators and their applications, Cauchy-Euler differential equations.	10 Hrs.	CLO4 , CLO5
5.	**Modelling with Second-order Equations**: Spring-mass systems, Free and undamped motion, Free and damped motion; Forced motion; Resonance phenomena, Electric circuit problems and their modeling, motion of a rocket.	6 Hrs.	CLO4 , CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	♦	-	-	♦	-	-	♦	-
CLO2	♦	-	♦	-	♦	-	-	♦	-	-	♦	-
CLO3	♦	♦	♦	-	♦	-	-	♦	-	-	♦	-
CLO4	♦	♦	♦	-	-	-	-	♦	♦	-	-	-
CLO5	♦	-	♦	♦	♦	♦	♦	♦	♦	-	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Boyce, W. E., DiPrima R. C., and Meade D. B.,** Elementary Differential Equations and Boundary Value Problems, *John Wiley & Sons*, 2021.
ii.	**Zill D. G.,** A first Course in Differential Equations with Modeling Applications, *Cengage Learning,* 2012.

Supplementary Readings

i.	**Kreyszig E., K.,** Advanced Engineering Mathematics, *Wiley,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz, Assignment (Formative) and Final Exam (Summative)
CLO2	Lecturing and Students Activity	Quiz, Assignment (Formative) and Final Exam (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Mid-Semester (Summative)
CLO4	Lecturing and Discussion	Assignment, Homework (Formative) and Final exam (Summative)
CLO5	Lecturing and Students Activity	Assignment (Formative), Mid-Semester and Final exam (Summative)

Course Title	Calculus of Several Variables	**ISCED Code**	0541-215
		Course Code	MTH 215
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Algebra, Geometry, Trigonometry and Calculus of single variables	**Total Marks**	100

Course Description

Calculus of Several Variables is a major course for the undergraduate students of the B.Sc. (Honors) program, which carries 3**.0 credits** and **42 hours** of effective teaching in 14 weeks. The course grades will be assessed through participation, class presentations, assignments, two midterms and comprehensive examinations. It requires successfully completion of **Algebra, Geometry, Trigonometry and Calculus of single variables** courses.

Rationale

Calculus is the mathematical study of change, in the same way that geometry is the study of shape and algebra is the study of operations and their application to solve equation. Calculus is concerned with two basic operations, differentiation and integrations, and is a tool used to determine such quantities as rates of change and areas. This course, **Calculus of Several Variables,** will give an overview of partialdifferentiation, functions of several variables and multiple integrations.

Course Objectives

This course **Calculus of Several Variables** represents the extension of calculus in one variable to calculus with functions of several variables. This course treats topics related to differential calculus in several variables and integration in several variables. Calculus of Several Variables has many applications in various areas such as pure mathematics, engineering and physics. In **Calculus of Several Variables**, students will become proficient with the differentiation and integration of functions involving multivariable as well as applications in real world such as volume and surface area. The aim of this course is to provide students with fundamental concepts and techniques of multivariable calculus and to develop students understanding and skills for its applications to other areas.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the concept of Euclidean-n space, Norm, Length and distance in n- space.
CLO2	Explainlimit, continuity and differentiability of a function of several variables.
CLO3	Identify geometrical meaning of partial derivatives, directional derivatives and gradient and solve integration of two or three variables and the iteration ofintegration.
CLO4	Simplify Jacobians-the effect of the change of variables in computation of single, Double and tripleintegrals and develop a powerful method for maximizing or minimizing a function subject to constraints on the several variables.
CLO5	Sketch different types of cylindrical quadric surfaces and compute multiple integrals in rectangular, polar, cylindrical and spherical coordinates.

Course Contents

	Course Contents	Hours	CLOs
1.	**Functions of Several Variables**: Limit and continuity, Partial derivatives, Differentiability, Linearization and differentials, Euler's theorem and its applications. The chain rule, Partial derivatives with constrained variables, Directional derivatives,	22 Hrs.	CLO1, CLO2, CLO3

	Gradient vectors and tangent planes, Extreme values and saddle points of functions of several variables, Lagrange multipliers and Taylor's formula.		
2.	**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 and Changes of variables in multiple integral, and Jacobians.	20 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	-	-	-	♦	-	-	-	-	-	-
CLO2	♦	-	-	-	-	-	-		-	-	-	-
CLO3	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	-	-	-	-	-	-	-	-	-	-	-
CLO5	♦	-	♦	-	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Swokowski E W.,** Calculus with Analytic Geometry, *Prindle, Weber & Schmidt,* 1983.
ii.	**Thomas G. B.,** Calculus and Analytic Geometry, *Addison-Wesley Pub Co.,* 1965.
iii.	**Lang S.,** First Course in Calculus, *Springer,* 1986.
iv.	**Bers L., and Karal P.** Calculus, *Laurie Rosatone*, 2012.
v.	**Anton H.,** Calculus, *Laurie Rosatone*, 2012.
vi.	**Stewart. J.,** Calculus: Early Transcendentals, *Cengage Learning*, 2014.
Vii.	**Smith R. T., and Minton R. B.,** Calculus, *New York, NY: McGraw-Hill,* 1955.
viii.	**Velleman D. J.,** Calculus: A Rigorous First Course, *Dover Publications*, 2017.

Supplementary Readings

i.	**Rudin W.,** Principle of Mathematical Analysis, *McGraw Hill*, 1953.
ii.	**Ayres F. and Mendelson E., Calculus, McGraw Hill,** *Schaum's Outline Series*,2013.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative), Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Group discussion	Final exam (Summative)
CLO3	Lecturing and Group discussion	Homework (Formative), Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group discussion	Final exam (Summative)
CLO5	Lecturing and Group discussion	Presentations (Formative), Mid-Semester and Final exam (Summative)

Course Title	Modern Physics	**ISCED Code**	0533-216
		Course Code	PHY 216
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Fundamentals of Mathematics, Fundamental of Physics and Calculus	**Total Marks**	100

Course Description

Modern Physics is a GED compulsory course for undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for understanding Modern physics. However, it requires successful completion of **Fundamentals of Mathematics, Fundamentals of Physics, Calculus and Geometry.**

Rationale

Modern Physics is an introductory physics course. Students will learn Heat and Radiation, Kinetic theory of Gases, Equation of states for gases, Thermal conductivity and Radiation. Students will also learn about radioactivity, nuclear reactors, nuclear fission, and nuclear fusion.

Course Objectives

This course aims to gain a basic understanding of heat and thermodynamics, thermodynamics function and Liquidification of Gases, and to provide knowledge about heat and radiation, equations of states for gases, and heat transfer.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Interprets basics concepts on modern physics.
CLO2	Understand about energy transfer in an electric circuit.
CLO3	Analyze and explain the components of Newtonian mechanics and uniform electric and Magnetic field.
CLO4	Apply the concepts of theories in differentphenomenon and circuits in series and parallel, Resonance, Q-factor, and Explain Planck's radiation formula, Photoelectric effect, Einstein's Photon theory.
CLO5	Basic ideas of nuclear reactor, nuclear fission and nuclear fusion. Approach and solve new problems in a range of advanced topics in physics especially in heat, nuclear reactor, nuclear fission and nuclear fusion and radiation.

Course Contents

	Course Contents	Hours	CLOs
1.	Gauss's law, Application of Gauss's law, Dielectrics and Gauss's law, Ohm's law, Energy transfer in an electric circuit.	7 Hrs.	CLO1, CLO2
2.	Kirchhoff's laws and their applications. Magnetic Induction, Motion of a charged particle in uniform electric and Magnetic field.	7 Hrs.	CLO1, CLO2, CLO3
3.	Concept of R.M.S. and average value of current and voltage, CR, LR and LCR circuits in series and parallel, Resonance, Q-factor.	7 Hrs.	CLO1, CLO2, CLO3
4.	Planck's radiation formula, Photoelectric effect, Einstein's Photon theory, The Compton effect, The Hydrogen atom and the correspondence principle.	6 Hrs.	CLO4, CLO5
5.	Matter waves, Atomic structure, Wave mechanics, Uncertainty principle and Atomic excitation.	7 Hrs.	CL03, CLO4, CLO5

6.	The nucleus, Nuclear force, Nuclear radius, Mass defect and packing fraction, Radio activity, Unstable nuclei, Exponential decay law.	3 Hrs.	CLO4, CLO5
7.	Half-life, Mean life, and units of radioactivity, Basic ideas of nuclear reactor, Nuclear fission and nuclear fusion.	5 Hrs.	CLO2, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	-	-	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	-	♦	♦	-	-	-	-	-	-	♦	-
CLO4	-	♦	-	-	♦	-	♦	-	♦	-	♦	♦
CLO5	♦	♦	♦	-	-	♦	♦	-	-	♦	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings:

i.	**Theraja B. L.,** Electricity Magnetism and Electronics, *S. Chand Publishing*, 2008.
ii.	**Beiser A.,** Concepts of Modern Physics, *McGraw Hill, 2002.*

Supplementary Readings

i.	**Eisberg, R. M.,** Fundamentals of Modern Physics, *John Wiley & Sons, Inc.,* 1990.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative), Mid-Semester (Summative)
CLO2	Lecturing and Group discussion	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group discussion	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)
CLO5	Lecturing, Questioning and Answer questioning	Presentations (Formative), Mid-Semester and Final exam (Summative)

Course Title	Programming with C and C++ Lab	**ISCED Code**	0714-217
		Course Code	CSE 217
Course Type	GED	**Course Status**	Lab
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Fundamentals of Computer	**Total Marks**	50

Course Description

Programming with C and C++ Lab is a compulsory GED laboratory course for the students of the B. Sc. (Honours) program. The course carries **2.0 credits** and **28 hours** of effective class teaching. Teaching techniques consist of traditional lectures, which include question-answer sessions and discussions, tests/quizzes over lecture materials, etc. Prerequisite of taking this course is the successful completion of **Programming with C and C++** theory course**.**

Rationale

The primary purpose of this course is to teach students the basics of pure programming and problem-solving. This course provides students with a comprehensive hands on the C and C++ programming languages. The course emphasizes problem-solving and empirical skills through the process of designing, implementing, and executing C and C++ programs.

Course Objectives

The main objective of **Programming with C and C++ Lab** is to provide exposure to problem-solving through programming. It aims to train the student in the basic concepts of the C-programming language. This course involves a lab component which is designed to give the student hands-on experience with the concepts.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Makes students gain a broad perspective about the uses of computers in engineering industry.
CLO2	Develops basic understanding of computer programming, the concepts of algorithms and algorithmic thinking.
CLO3	Develops the ability to analyze a problem and solve it with algorithm.
CLO4	Develops the use of the C programming language to implement various algorithms and develops the basic concepts and terminology of programming in general.
CLO5	Students are able to solve programming contest problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Problem Solving Techniques:** Problem analysis, Algorithm, Flowchart, Debugging, Coding and Documentation.	10 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5
2.	**Structured programming language:** Overview of C, Data types, Variables, Constants, Operators, Expressions, Control structures, Functions and program structure, Parameter passing conventions, Scope rules and storage Classes, Recursion, Header files, Pre-processor, Pointers and arrays, Strings, Multidimensional array, User defined data types, Structures, Unions, Enumerations, Input and Output, Standard input and output, Formatted input and output, File access, Variable length argument list, Command line parameters, Error Handling, Graphics, Linking, and Library functions.	18 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	♦	-	♦	-	-	♦	-
CLO2	♦	♦	-	♦	-	♦	♦	♦	-	♦	-	♦
CLO3	♦	-	♦	-	-	♦	-	-	-	-	♦	_
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Course Plan

Detail Course Plan with Teaching-Learning and Assessment Strategy				
Week	**Topic**	**Teaching-Learning Strategy**	**Assessment Strategy**	**CLOs**
1.	Problem solving techniques, Problem analysis.	Lecturing and Students activity	Quiz/Homework (Formative) and Midterm (Summative)	CLO1

Learning Materials

Recommended Readings

i.	**Ritchie D.,** The C programming language. *Prentice Hall,* 2008.
ii.	**Balagurusamy E.,** Programming in ANSI C, *McGraw Hill*, 2017.

Supplementary Readings

i.	**Stephen G. K.,** Programming in C, *Addison-Wesley Professional,* 2014.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing, Students Activity, Group discussion	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Group discussion	Homework (Formative), Mid-Semester and Final exam (Summative)
CLO3	Lecturing, Students Activity, Group discussion	Homework (Formative), Mid-Semester and Final exam (Summative)
CLO4	Lecturing, Students Activity, Group discussion	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)
CLO5	Lecturing and Students Activity	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)

Second Year Second Semester

Course Title	Real Analysis II	**ISCED Code**	0541-221
		Course Code	MTH 221
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Real Analysis I, Calculus, Set Theory and Geometry	**Total Marks**	100

Course Description

Real Analysis II is a major, compulsory and core course for undergraduate students in the B. Sc. (Honours) program. It carries **3.0 credits** and **42 hours** of effective teaching over **14 weeks**. Course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This course is an advanced undergraduate or graduate-level course that builds upon the foundational concepts of Real Analysis I. However, it requires **Real Analysis I,Calculus, Set Theory, Basic Algebra and Geometry**.

Rationale

This course typically covers topics related to the analysis of functions of several variables, including integration and differentiation of functions of several variables, metric spaces, and differential equations. The course will begin with a review of the fundamentals of Real Analysis I, such as the topology of metric spaces, sequences and series, and continuity and differentiability of functions. Then, the course will progress to more advanced topics, including integration theory in several variables, differentiation of functions of several variables, the implicit and inverse function theorems, and the calculus of variations.

Course Objectives

Real Analysis II builds upon the foundational concepts of Real Analysis I and aims to develop students' analytical and problem-solving skills in more advanced topics in analysis. The course aims to provide students with a rigorous study of the theory of functions of several variables. It also aims to develop their skills in applying these concepts to solving problems for advanced analysis in mathematics, including topology, measure theory, functional analysis, and other advanced topics in analysis. This course helps students develop their analytical and problem-solving skills, which are valuable in many professions, including academia, finance, and data science.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the limits, continuity, and differentiability. Economists use limits to analyze the behavior of markets in the long run, and they use differentiability to optimize production and pricing decisions.	to describe the fundamental properties of real numbers that facilitate the formal development of real analysis.
CLO2	Teach students some basic theorems, such as the intermediate value theorem, mean value theorem, and fundamental theorem of calculus, and their applications to real-world problems.	teach students the fundamentals of topology, which are used in limits, continuity, and convergence.
CLO3	The basic concepts of integration of real functions are used to calculate the area, volume, and other geometric properties of shapes.	comprehend the properties of metric spaces, which are used in geography and navigation to calculate distances between points on the Earth's surface.
CLO4	Familiar with the sequence and series of functions used in analysis to study the	understand the concepts of an infinite series of real numbers, including convergence tests

	convergence and divergence of functions and their derivatives.	and the concept of absolute convergence.
CLO5	Introduce Euclidean n-spaces used in robotics to model robot position and movement in multiple dimensions.	

Course Contents

	Course Contents	Hours	CLOs
1.	**Real Continuous Functions:** Limit and continuity of functions, Local properties, Global properties (global continuity theorem, Preservation of compactness, Maximum and minimum value theorem, Intermediate value theorem, Preservation of connectedness) and Uniform continuity of functions.	9 Hrs.	CLO1
2.	**Differentiability of Real Functions:** Basic properties, Rolle's theorem, Mean value theorem and Taylor's theorem.	6 Hrs.	CLO2
3.	**Integration of Real Functions:** Riemann sum and Riemann integral, Conditions for integrability, Properties of integrals, Darboux sums, Darboux theorem, Fundamental theorem of integral calculus, Mean value theorem for integrals, Leibnitz's theorem on differentiation under the integral sign and Riemann-Stieltjes integration.	9 Hrs.	CLO3
4.	**Sequences and Series of Real Functions:** Pointwise 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.	9 Hrs.	CLO4
5.	**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 and Fubini's theorem.	9 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦	♦
CLO2	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦	♦
CLO3	♦	♦	-	♦	♦	♦	-	♦	♦	♦	-	-
CLO4	♦	♦	♦	-	♦	♦	-	♦	♦	♦	-	-
CLO5	♦	♦	♦	♦	-	♦	-	♦	♦	♦	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

ii.	**Sharma J. N., and Batishta A. R.,** Real Analysis, *Krishna Prakashan Media,* 2014.
iii.	**Narayan S. and Mittal P. K.,** A course on Mathematical Analysis*, S. Chand & Publishing Co.,* 2007.
iv.	**Ross K. A.,** Elementary Analysis: The Theory of Calculus, *Springer,* 2013.

Supplementary Readings

i.	**Chatterjee D.,** Real Analysis, *PHI Learning,* 2012.
ii.	**Bartle R. G., and Sherbert D.,** Introduction to Real Analysis, *Wiley,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing, Students Activity, Group discussion	Assignment and Presentations (Formative), Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)
CLO3	Lecturing, Group Discussion and Questioning, and Answer questioning	Homework (Formative) and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing,Questioning, and Answer questioning	Presentations (Formative), Mid-Semester and Final exam (Summative)

Course Title	Linear Algebra II	**ISCED Code**	0541-222
		Course Code	MTH 222
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Elementary Linear Algebra	**Total Marks**	100

Course Description

Linear Algebra II is one of the most fundamental and major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course that blends the theoretical (pure) and computational (applied) study of Mathematics.

Rationale

Linear Algebra II builds upon the foundational concepts covered in Linear Algebra I and provides a rigorous and abstract perspective on the subject. It equips students with the necessary tools to solve complex problems in various fields. By studying similarity and canonical forms, students gain a deeper understanding of matrix structure and properties. The exploration of linear functionals and dual spaces enhances their ability to analyze and manipulate vector spaces, solving problems related to linear transformations and change of basis. The study of orthogonality, including inner product spaces and orthogonal matrices, enables students to tackle problems involving projections, least squares approximations, and spectral analysis. Analyzing bilinear, quadratic, and Hermitian forms deepens their understanding of quadratic equations and optimization problems. Diagonalization, singular value decomposition, and the pseudoinverse are essential tools for analyzing linear transformations and their applications in image processing. Understanding positive definite matrices and optimization techniques equips students with powerful tools to solve optimization problems and analyze critical points. This course fosters critical thinking and problem-solving skills, preparing students for further studies in mathematics and its diverse applications.

Course Objectives

Upon completion of this course, students will be able to accurately define and appropriately illustrate fundamental concepts of linear algebra such as similar matrices, canonical forms, linear functionals and dual spaces, orthogonality, bilinear, quadratic, and Hermitian Forms, Diagonalizability and Positive definiteness. They will understand the basic ideas and techniques of linear algebra for use in many other lecture courses. They will know some basic ideas of linear algebra and techniques of proof which will be useful for future courses in pure mathematics. Students will be able to apply specific linear algebra concepts, thinking processes, tools and techniques to solve conceptual and real-life problems. At the end of the course, it is hoped that the students will feel the beauty and necessity of the language of linear algebra to solve problems dealing with real-world phenomena. They will be capable of thinking logically and analytically to be able to manipulate ideas of valuable ends.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Accurately understand and use the properties of similar matrices. Also, define and illustrate the concepts of canonical forms of matrices, symmetric, orthogonal and Hermitian matrices.
CLO2	Know the linear functionals, the dual space, dual basis, second dual space, change of basis, annihilators, dual of a linear transformation.

CLO3	Demonstrate knowledge and understanding of the basic concepts related to inner product spaces, and show proficiency in using the Gram-Schmidt process to construct an orthonormal basis, and know the operator theory and apply them into the spectral theorem and understand the concept and properties of bilinear, quadratic and Hermitian forms and demonstrate them into canonical forms, and determine the definite, semi-definite forms and minors.
CLO4	Recognize the diagonalization process, and show proficiency in determining if a matrix is diagonalizable and apply matrix decomposition to real world problems such as image processing and many other fields.
CLO5	Show mastery in testing positive definiteness of matrices, and in finding the Minima, Maxima, and Saddle Points and apply linear algebra concepts, thinking processes, theory, methods, tools and techniques to solve mathematical and real-life problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Similar Matrices:** Canonical forms of matrices, Symmetric, Orthogonal and Hermitian matrices.	6 Hrs.	CLO1
4	**Linear Functional and Dual Space:** Linear functionals, the Dual space, Dual basis, Second dual space, Change of basis; Annihilators, Dual of a linear transformation.	6 Hrs.	CLO2, CLO4
3.	**Orthogonality:** Inner products, Norms and projections 0nto lines, Inner product spaces, Projections and Least squares approximations, Orthogonal and orthonormal sets, Orthogonal matrices, Gram-Schmidt orthogonalization, the adjoint of a linear operator, Normal and Self-adjoint operators, Unitary and orthogonal operators, the Spectral theorem.	9 Hrs.	CLO3, CLO5
4.	**Billinear, Quadratic and Hermitian Forms:** Bilinear forms, Quadratic forms, The normal form, Hermitian forms, Reduction forms, Definite and Semi-definite forms.	8 Hrs.	CLO4, CLO5
5.	**Diagonalization:**Diagnolizability of matrices, The Singular value decomposition and its applications to image processing, the Pseudo inverse.	7 Hrs.	CLO4, CLO5
6.	**Positive Definite Matrices:**Maxima, Minima and Saddle points, Tests for positive definiteness, Semidefinite and Indefinite matrices, Minimum principles.	6 Hrs.	CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	♦	-	-	♦	-	-	♦	-
CLO2	♦	-	♦	-	♦	-	-	♦	-	-	♦	-
CLO3	♦	♦	♦	-	♦	-	-	♦	-	-	♦	-
CLO4	♦	♦	♦	-	♦	♦	♦	♦	♦	-	♦	-
CLO5	♦	♦	♦	♦	♦	♦	♦	♦	♦	-	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Anton H. and Rorres C.,** Elementary Linear Algebra: Applications Version, *John Wiley & Sons,* 2013.
ii.	**Lipschutz S.,** Linear Algebra 4th Edition, *McGraw-Hill*, 2009.

Supplementary Readings

i.	**Strang G.,** Linear Algebra and its Applications. Belmont, CA: Thomson, *Brooks/Cole*, 2006.
ii.	**Lay D. C., Lay S. R., and McDonald J.**, Linear Algebra and its Applications, *Pearson*, 2016.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Discussion and Question and Answer questioning	Mid-Semester and Final exam (Summative)
CLO2	Lecturing, students activity and Discussion	Homework and Presentation (Formative) and Final exam (Summative)
CLO3	Lecturing, students activity and Discussion	Homework and Assignment (Formative) and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Presentation and Assignment (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing and Group Discussion	Homework and Assignment (Formative) and Final exam (Summative)

Course Title	Numerical Analysis II	**ISCED Code**	0541-223
		Course Code	MTH 223
Course Type	Core	**Course Status**	Theory
Course Hour	3 hr./week	**Credit Value**	3.0
Prerequisite	Real analysis, Linear Algebra, Numerical Analysis-I and Ordinary Differential Equations	**Total Marks**	100

Course Description

Numerical Analysis II is one of the most fundamental and major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. **Numerical Analysis II** is the area of mathematics that creates, analyzes, and implements algorithms for solving numerically the problems of continuous mathematics. Such problems generally originate from real-world applications of algebra, geometry and calculus, and they involve variables which vary continuously; these problems occur throughout the natural sciences, social sciences, engineering, medicine, and business.

Rationale

Numerical Analysis II is being used as the analytical tool for obtaining solutions at discrete points of such problems. Almost all the initial and boundary value problems encountered in the realm of science and engineering are not tractable/ amenable to solving analytically. The rapid development of computers enhances the application of numerical methods for solving practical problems. The role and importance of numerical methods through their application are growing in diverse areas of physical phenomenon. The subject on the topic is excellent in developing skills for solving initial value problems and boundary value problems by using Finite difference Methods, and this will lay the foundations to learn other powerful numerical methods.

Course Objectives

Numerical Analysis II, it outlines the importance and necessity of numerical methods. This course provides sufficient knowledge for developing various numerical methods for solving initial boundary value problems. It is familiar with stability and error analysis of various numerical techniques. This course enhances computing ability using computer algebra, Packages and self-computer coding. It accomplishes projects on finite difference methods for solving real-world problems.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	To outline the importance and necessity of numerical methods and use computer algebra, packages and writing self-computer code.
CLO2	Improve the existing methods and algorithms and solve system of non-linear equations.
CLO3	Solve initial value problems by using various numerical techniques and solve boundary value problems described by parabolic, hyperbolic and elliptic partial differential equations.
CLO4	Accomplish projects on initial and boundary value problems and find out the real life applications of this course and the construction of FORTRAN, MATHEMATICA and MATLAB programs for numerical solutions.
CL05	Develop a number of algorithms and codes which they can apply as a reliable tool in later subjects and projects and accomplish projects on different topics relevant with the content of the subject.

Course Contents

	Course Contents	Hours	CLOs
1.	**Iterative Techniques of Matrix Algebra:** Iterative technique for solving linear systems of equations, Error estimates and iterative refinement, eigenvalues and eigenvectors, the power method, Householder's method, Q-R method.	12 Hrs.	CLO1, CLO2 CLO3
2.	**Numerical Solution of Non-linear System:** Fixed point method for functions of several variables, Newton's method, Quasi-Newton's method.	6 Hrs.	CLO2, CLO4

3.	**Initial Value Problem for ODEs:** Euler's method and modified Euler's method, Higher order Taylor's method, Single-step method: Runge-Kutta methods, extrapolation methods-higher order differential equations and system of differential equations), Multi-step methods: Adams-Bashforth, Adams-Moulton, Predictor-Corrector and Hybrid methods, variable step-size multi-step methods, Error and stability analysis.	15 Hrs.	CLO2, CLO4, CLO5
4.	**Boundary Value Problem for ODEs:** Shooting method for linear and nonlinear problems.	6 Hrs.	CLO2, CLO5
5.	**Programs:** Construction of FORTRAN and MATLAB programs for numerical methods.	3 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	♦	♦	♦	-	♦	-	♦	♦
CLO2	♦	♦	♦	♦	♦	-	♦	♦	♦	♦	♦	♦
CLO3	♦	♦	-	♦	♦	-	♦	-	-	-	♦	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	-	-	♦	♦
CLO5	♦	-	♦	-	-	-	♦	-	-	-	-	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Burden R. L., and Faires J. D.,** Numerical Analysis, *Brooks/Cole*, 2011.
ii.	**Sastry S. S.,** Introductory Methods of Numerical Analysis, *Prentice-Hall of India*, 2008.
iii.	**Vasishtha A. R., and Vasishtha V.,** Numerical Analysis, *KedarNath Ram Nath*, 2001.

Supplementary Readings

i.	**Gerald C. F. and Wheatley P. O.,** Applied Numerical Analysis, *Pearson*, 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Students Activity and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing, students activity and Discussion	Homework and Presentation (Formative) and Final exam (Summative)
CLO3	Lecturing, students activity and Discussion	Homework and Assignment (Formative) and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Presentation and Assignment (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing and Group Discussion	Homework and Assignment (Formative) and Final exam (Summative)

Course Title	Ordinary Differential Equations II	**ISCED Code**	0541-224
		Course Code	MTH 224
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Ordinary Differential Equations	**Total Marks**	100

Course Description

Ordinary Differential Equations II is a fundamental course that is required for undergraduate students in the B. Sc. (Honors) program. It carries **3.0 credits** and consists of **42 hours** of effective teaching over **14 weeks**. The assessment for this course includes participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This course is essential as it combines both theoretical and computational aspects of studying mathematics. A prerequisite of taking this course is the successful completion of **Calculus and Ordinary Differential Equations I**.

Rationale

The course **Ordinary Differential Equations II** builds upon the foundations established in Ordinary Differential Equations, aiming to deepen students' understanding and proficiency in solving differential equations. Students will develop advanced problem-solving skills by delving into topics such as the series solutions for second-order linear equations. They will also explore the application of series solutions to specific types of differential equations, including Legendre, Bessel, Laguerre, and Hermite equations. Through a comprehensive understanding of Legendre functions, Bessel functions, Hermite polynomials, and Laguerre polynomials, students will gain the necessary tools to tackle diverse real-world problems in fields such as physics, engineering, and mathematics. This course fosters a robust theoretical foundation and practical expertise, enabling students to analyze and solve a wide range of differential equations with confidence and relevance to real-world scenarios.

Course Objectives

The objective of the course **Ordinary Differential Equations II** is to equip students with advanced skills and knowledge in the field of differential equations. By mastering series solutions, including the Taylor series and Frobenius series, students will be able to solve second-order linear differential equations and apply these techniques to specific types of equations, such as Legendre, Bessel, Laguerre, and Hermite equations. The course aims to foster a comprehensive understanding of Legendre functions, Bessel functions, Hermite polynomials, and Laguerre polynomials, including their properties, recurrence relations, and expansion theorems. Ultimately, students will develop the skills necessary to analyze and solve various differential equations, ranging from second-order linear equations to systems of first-order linear equations, and apply this knowledge to practical scenarios in fields such as physics, engineering, and mathematics.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO 1	Solve second-order linear equations using series solutions, including Taylor series solutions about ordinary points and Frobenius series solutions about regular singular points and apply series solutions to solve specific types of differential equations, such as Legendre, Bessel, Laguerre, and Hermite equations.
CLO 2	Demonstrate a deep understanding of Legendre functions, including their generating function, recurrence relations, expansion theorem, and associated Legendre functions.
CLO 3	Apply Bessel functions to solve problems, including understanding their generating function, recurrence relations, orthogonality relations, and modified Bessel functions.
CLO 4	Solve differential equations involving Hermite and Laguerre polynomials, including, understanding their generating function, Rodrigues' formula, orthogonal properties, recurrence relations, and expansion theorems.
CLO 5	Analyze systems of linear first-order differential equations using methods such as elimination, matrix methods for homogeneous linear systems with constant coefficients, variation of parameters, and matrix exponential. Additionally, apply the learned techniques to solve real-world problems modeled by differential equations, with a focus on systems of equations and higher order equations.

Course Contents

	Course Contents	Hours	CLOs
1.	**Series Solutions of Second Order Linear Equations:** Taylor series solutions about an ordinary point, Frobenious series solutions about regular singular points, Series solution of Legendre, Bessel, Laguerre and Hermite equations, and Hypergeometric equations.	15 Hrs.	CLO1, CLO2
2.	**Legendre Functions**: Generating function, Recurrence relations and other properties of Legendre polynomials, Expansion theorem, Legendre differential equation, and Legendre function of first kind, Legendre function of second kind and associated Legendre functions.	6 Hrs.	CLO1, CLO3
3.	**Bessel Functions**: Generating function, Recurrence relations, Bessel differential equation, Integral representations, Orthogonality relations, and Modified Bessel functions.	6 Hrs.	CLO1, CLO2, CLO4
4.	**Hermite and Laguerre Polynomials:** Generating function, Rodrigue‟s formula, Orthogonal properties, Hermite and Laguerre differential equation, Recurrence relations, and expansion theorems.	9 Hrs.	CLO2, CLO3, CLO5
5.	**System of Linear First Order Differential Equations:** Elimination method, Matrix method for homogeneous linear systems with constant coefficients, Variation of parameters and Matrix exponential.	6 Hrs.	CLO1, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	♦	-	-	-	-	-	-	♦	♦
CLO2	♦	-	♦	♦	♦	♦	-	-	♦	♦	♦	♦
CLO3	♦	♦	♦	♦	♦	♦	-	-	♦	♦	♦	♦
CLO4	♦	♦	♦	-	♦	♦	-	-	♦	♦	♦	♦
CLO5	♦	♦	♦	-	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Boyce W. E., DiPrima R. C. and Meade D. B.,** Elementary Differential Equations and Boundary Value Problems, *John Wiley & Sons*, 2021.
ii.	**Zill, D. G.,** A first Course in Differential Equations with Modeling Applications, *Cengage Learning,* 2012.
iii.	**Ross S. L.,** Differential Equation*, Jhon Wiley & Sons. Inc. New York*, 1984.
iv.	**Silverman R. A.,** Special Functions and their Applications, *Courier Corporatio*n, 1972.

Supplementary Readings

i.	**Brauer F., and John A. N.,** Ordinary Differential Equations: A First Course, *Addison Wesley Longman,* 1973.
ii.	**Sharma, J. N.,** Special Functions, *Krishna Prakashan Media,* 1991.
iii.	**Kreyszig E., K.,** Advanced Engineering Mathematics, *Wiley,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing, Students Activity	Assignment and Presentation (Formative) and Mid-Semester
CLO2	Lecturing and Discussion	Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing, Question and Answer Questioning	Homework and Assignment (Formative) and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Presentation and Assignment (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing and Group Discussion	Homework and Assignment (Formative) and Mid-Semester and Final exam (Summative)

Course Title	Programming with FORTRAN	**ISCED Code**	0541-225
		Course Code	MTH 225
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Computer Fundamentals, Numerical Analysis	**Total Marks**	100

Course Description

Programming with FORTRAN is a GED Theory course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and 4**2hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. Fortran is a language that is specialized for high-performance computing and it is easy to learn and provides efficient constructs that are useful for numerical calculations. However, it requires successfully completion of Computer Fundamentals and Numerical analysis.

Rationale

FORTRAN is one of the principal languages used in scientific, numerical and engineering programming and knowledge in FORTRAN is an indispensible 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

- Students will be developed a greater understanding of the issues involved in programming language design and implementation.
- To develop an in-depth understanding of functional, logic and object- oriented programming paradigms.
- To understand design/implementation issues involved with variable allocation and binding, control flow, types, subroutines, parameter passing.
- It will be developed an understanding of the compilation process.
- To furnish the students with the opportunities of coding and developing customized as well as workable programs for science, engineering, business and personal needs.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand basic programming concepts.
CLO2	Divide a problem into its logical set of components
CLO3	Understand how good program design reduces coding and debugging time.
CLO4	Learn algorithm development for structured programming, designing, coding, debugging, and documenting programs and analyze and interpret data.
CLO5	Think in a logical sequential process and use this language to solve moderate scientific and engineering computation problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Basic Concepts:** Introduction to Computer Programming, Structure of Fortran statement, Program Structure, Data type, Constants, Variables, Operators and Operations, Intrinsic Functions and List directed I/O.	10 Hrs.	CLO1, CLO2, CLO5

2.	**Operators:** Logical Operators and Logical Expression, If Constructs, The Case Construct and Do Loops.	10 Hrs.	CLO3
3.	**Charts:** Flowcharts, Algorithms and Pseudo codes.	6Hrs.	CLO4 ,CLO5
4.	**Solving problems in Numerical Analysis Using FORTRAN:** Construction of FORTRAN program for problems drawn from mathematics and sciences.	16 Hrs.	CLO1 , CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	-	♦	-	-	-	-	-
CLO2	♦	♦	-	♦	-	♦	♦	-	-	-	-	-
CLO3	♦	♦	♦	-	♦	♦	♦	-	-	-	-	-
CLO4	♦	♦	♦	-	♦	-	♦	-	-	-	-	-
CLO5	♦	-	♦	-	♦	-	♦	-	♦	-	-	-

Learning Materials

Recomended Reading

i.	**Desai R. C.,** FORTRAN programming and numerical methods, *Tata McGraw-Hill Publishing Co., Ltd*., 1991.
ii.	**Stephen J. C.,** Introduction to FORTRAN 90/95 for Scientists and Engineers, McGraw-*Hill Science/Engineerin*; 1st Edition, 1997.

Supplementary Readings

i.	***Mayeo, W. E. E.,*** Theory and Problems of Programming with Fortran 77, *Schaum's Outline,* 1994.
ii.	**Lipschutz S. and Poe A.** Programming with FORTRAN Including Structured FORTRAN, *Schaum's Outline,* 1978.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Slide Presentation	Quiz
CLO2	Lecturing and Visual Presentation	Homework and Mid-Semester
CLO3	Lecturing and Questioning and Answer Questioning	Presentation and Mid-Semester
CLO4	Lecturing and Group Discussion	Summative Exam
CLO5	Lecturing and Group Discussion	Assignment and Summative Exam

Course Title	Math Lab I: Programming with FORTRAN	**ISCED Code**	0541-226
		Course Code	MTH 226
Course Type	GED	**Course Status**	Lab
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Numerical Analysis I and II, Programming with FORTRAN.	**Total Marks**	100

Course Description

Math Lab: I: Programming with FORTRAN is a GED laboratory course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credits** and **28 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. Fortran is a language that is specialized for high-performance computing and it is easy to learn and provides efficient constructs that are useful for numerical calculations. However, it requires successfully completion of introduction to computer, Programming with FORTRAN and Numerical analysis.

Rationale

The implementation of theories/ methods employing programming knowledge broadens the contented knowledge and that also enhances computer skills. With this aim numerical analysis lab course is designed. This course will emphasize to develop self-written computer codes in FORTRAN. Now a day, Numerical Analysis has got immense application in many areas of science and engineering. The undergraduate population, after completion of the course will be able to contribute in scientific computations.

Course Objectives

Writing programs for each task oriented techniques of numerical analysis and practicing. To enable graduates to apply various tools and techniques to solve problems in mathematical sciences. To show the application of basic theories/ methods for obtaining approximate solution of practical problems. To acquire skills to accomplish large computational projects for future implementation.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Read, understand and recognize Fortran program for each task oriented techniques/ methods of numerical analysis.
CLO2	Construct interpolating polynomials and relevant estimations.
CLO3	Realize the basic structure of a Fortran program.
CLO4	Learn some of the basic Fortran syntax and Compile and run a Fortran program and present accurate and robust algorithms for developing computer codes in order to solve mathematical as well as engineering problems.
CLO5	Develop a number of algorithms and codes which they can apply as a reliable tool in later subjects and projects and modify, develop and write an Algorithm and Fortran programs.

Course Contents

	Course Contents	Hours	CLOs
1.	Programming concepts on FORTRAN	**10 Hrs.**	CLO1, CLO2, CLO4, CLO5
2.	Solving problems in Numerical Analysis Using FORTRAN	**18 Hrs.**	CLO3, CLO4

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	-	♦	-	-	-	-	-
CLO2	♦	♦	-	♦	-	♦	♦	-	-	-	-	-
CLO3	♦	♦	♦	-	♦	♦	♦	-	-	-	-	-
CLO4	♦	♦	♦	-	♦	-	♦	-	-	-	-	-
CLO5	♦	-	♦	-	♦	-	♦	-	♦	-	-	-

Learning Materials

Recommended Reading

i.	**Desai R. C.,** FORTRAN programming and numerical methods, *Tata McGraw-Hill Publishing Co., Ltd*., 1991.
ii.	**Stephen J. C.,** Introduction to FORTRAN 90/95 for Scientists and Engineers, McGraw-*Hill Science/Engineerin*; 1st Edition, 1997.

Supplementary Readings

i.	**Mayeo, W. E. E***.,* Theory and Problems of Programming with Fortran 77, *Schaum's Outline,* 1994.
ii.	**Lipschutz S. and Poe A.** Programming with FORTRAN Including Structured FORTRAN, *Schaum's Outline,* 1978.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Slide Presentation	Quiz
CLO2	Lecturing and Visual Presentation	Homework and Mid-Semester
CLO3	Lecturing and Questioning and Answer Questioning	Presentation and Mid-Semester
CLO4	Lecturing and Group Discussion	Summative Exam
CLO5	Lecturing and Group Discussion	Assignment and Summative Exam

Course Title	Comprehensive Viva	**ISCED Code**	0541-299
		Course Code	MTH 299
Course Type	Core	**Course Status**	Oral/Presentation
Course Hour	---	**Credit Value**	2
Prerequisite	Recommended Books and Lecture Materials	**Total Marks**	100

Course Description

Comprehensive Viva is a major compulsory and core course for undergraduate students of B. Sc. Students pursue a **2.0 credit** (Honors) program, requiring effective teaching in the first and second semesters. Course grades will be assessed through participation, class presentations, quizzes, and comprehensive examinations. However, it requires successful completion of all courses in the first and second semesters.

Rationale

Yearly Comprehensive viva gives students the opportunity to demonstrate their understanding of the subject and answer questions.

Course Objectives

This is a platform to practice and show their smartness and confidence, as well as to address immediate issues in the society.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Realize themselves through oral assessment that helps students develop valuable communication skills.
CLO2	Enable interactive dialogue between candidate and assessor, allowing the examinee to demonstrate strengths and letting examiners discriminate between superficial and real knowledge via in-depth questioning.
CLO3	Have the ability to tailor the questions asked to the needs of each individual.
CLO4	Assess on the spot. Recent years have seen this traditional form of assessment used mostly to defend different subjects.
CLO5	In order to discriminate among the top achieving students, higher order cognitive skills can be tested by in-depth questioning.

Course Contents

	Course Contents	Duration	CLOs
1.	Students respond orally to questions during the comprehensive viva examination. These tests frequently draw from both the first and second semesters' worth of coursework. A vital component of academic programs, viva exams are frequently administered at the end of each academic year.	First and Second Semester	CLO1, CLO2, CLO3, CLO4, CLO5
2.	These Viva examinations formed part of the theory component of the final summative examination in the second semester of the first year. Since the Viva Voce is conducted for all students irrespective of their passing status in theory, the exercise is time consuming. To determine the impact of viva voce examinations on summative examination performance, this study has been conducted.		

3.	The main focus of the assessment is on the written/ thesis/dissertation (and other outputs, for a Practice as Research students) in communicative English, basic computer knowledge, physics, statistics, algebra, geometry in two dimensions and differential calculus. Since mathematics is a fundamental subject, job-seeking students should investigate it at many organizations in the labor market. Viva voce is necessary to make mathematics appealing to the business and research fields.		

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	♦	-	♦	-	-	-	-
CLO2	♦	♦	♦	♦	-	-	-	-	-	-	-	-
CLO3	-	♦	-	♦	-	♦	♦	♦	♦	-	♦	-
CLO4	-	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦
CLO5	-	-	♦	-	-	-	-	-	♦	♦	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	All the recommended books of Second Year 1st and 2nd semester.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Short questions, Quiz or Presentation
CLO2	Lecturing and Discussion	Short questions, Quiz or Presentation
CLO3	Lecturing and Group Discussion	Short questions, Quiz or Presentation
CLO4	Lecturing and Group Discussion	Short questions, Quiz or Presentation
CLO5	Lecturing and Students Activity	Short questions, Quiz or Presentation

Third Year First Semester

Course Title	Complex Analysis I	**ISCED Code**	0541-311
		Course Code	MTH 311
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./week	**Credit Value**	3.0
Prerequisite	Fundamentals of Mathematics	**Total Marks**	100

Course Description

Complex Analysis I is a major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and 4**2 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for understanding the complex analysis. However, it requires successful completion of **Fundamentals of Mathematics**, **Calculus** and **Real Analysis I and II** courses.

Rationale

This course focuses on the study of holomorphic functions and their most important basic properties. Topics covered are analytic functions, harmonic functions, and complex integration. In this course, students will learn algebra and geometry of complex numbers, mappings in the complex plane, the calculus of functions of a single complex variable, analyticity of a complex function, theory of multi-valued functions, introduction to complex number system, limits and continuity of complex variable functions, derivation of the Cauchy–Riemann complex functions have numerous applications in areas such as engineering, physics, differential equations and number theory, to name just a few.

Course Objectives

This course is designed to introduce basic notions and methods of a function of a complex variable, analytic functions, and complex integrations. Students will learn the basic ideas of complex numbers and functions, the limit, continuity and differentiability of complex functions, theorems related to the differentiation of complex functions, the harmonic function, the analytic function and the Cauchy-Riemann equation. They will learn about Cauchy and Morera's theorem, the complex form of Green's Theorem, the extension of Cauchy's theorems, the Cauchy-Goursat theorems and related problems.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts and fundamental principles ofcomplex analysis such as complex number, properties of complex number, complex functions, analytic function, C-R equation, Cauchy's theorem, and Harmonic function and so on.
CLO2	Represent complex numbers and their mathematical operations geometrically. Distinguish between a general argument and the principal value of the argument.
CLO3	Develop a strong foundation in limits/continuity/differentiability and then compare them between real valued function and complex valued function.
CLO4	Illustrate the concepts of complex analysis in the wide range for mathematical analysis and problem solving in calculus, basic algebra and real analysis.
CLO5	Familiarity with the different theorems of complex analysis such as Cauchy's theorem, extension of Cauchy's theorem, the Cauchy-Goursat theorem and Morera's theorem and apply those theorem in the field of engineering and Evaluate integrals along a path in the complex plane and apply different theorems for solving complex problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Complex Number and Functions of a Complex Variable:**Complex number system, Function of a complex variable, Mappings, Limits, Theorems on limits, Continuity and uniform continuity.	10 Hrs.	CLO1, CLO2, CLO3, CLO5
2.	**Analytic Function:** Derivatives, Analytic functions, Cauchy-Riemann equations (Cartesian and Polar form), Harmonic functions, Milne Thomson method, Geometric interpretation of the derivatives, Differentials, Rules for differentiation, Derivatives of elementary functions, Higher order derivatives, L'Hopsital's rules, Singular points, Orthogonal families, Curves, Applications, Gradient, Divergence, Curl and Laplacian, Identities involving gradient, Divergence and curl.	16 Hrs.	CLO1, CLO2, CLO4, CLO5
3.	**Complex Integration**: Complex line integrals, Real line integrals, Connection between real and complex line integrals, Properties of integrals, Change of variables, Simply and Multi-connected regions, Jordan curves, Complex form of Green's theorem, Cauchy's theorem, Extension of Cauchy's theorems, The Cauchy-Goursat theorems, Morera's theorem, Cauchy's integral formula and related problems by using different theorems.	16 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	♦	-	-	-	♦	♦	-	♦	-
CLO3	♦	-	♦	♦	-	-	-	♦	♦	♦	♦	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
CLO5	♦	♦	♦	♦	♦	♦	-	♦	♦	♦	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Charchill R. V.,** Complex Variable and Application,*McGraw Hill*, 2013.
ii.	**Spiegel M. R.,** Complex Variable, *McGraw Hill*, 2009.

Supplementary Readings

i.	**Choudhary B.,** The Elements of Complex Analysis, *Wiley*, 1983.
ii.	**Zill D. G. and Shanahan P. D.,**A first course in complex analysis with applications, *Jones and Bartlett Publishers*, 2003.

Teaching-Learning and Assessment

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz and Midterm
CLO2	Lecturing and Discussion	Assignment and Summative
CLO3	Lecturing and Slide Presentation	Summative Exam
CLO4	Slide Presentation and Questioning and Answer questioning	Homework and Summative Exam
CLO5	Group Discussion and Slide Presentation	Presentation and Summative Exam

Course Title	Abstract Algebra I	**ISCED Code**	0541-312
		Course Code	MTH 312
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	3.0
Prerequisite	Complex Analysis, Linear Algebra and Real Analysis	**Total Marks**	100

Course Description

Group Algebra is a core compulsory course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of group and their structures. However, it requires successful completion of **Complex Analysis, Linear Algebra and Real Analysis** courses.

Rationale

Group Algebra is a common name for the sub-area in Mathematics that studies algebraic structures such as groups, rings, fields, modules, vector spaces, and algebras. The study of Abstract Algebra has 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 learners to basic concepts from Abstract Algebra, especially the notion of a group. The course will help to prepare learners for further study in **Group Algebra** as well as familiarize them with tools essential in many other areas of Mathematics. The other aim of this course is to provide the learner with the skills, knowledge and competencies to carry out their duties and responsibilities in a pure Mathematic environment.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Learn different kinds of relations such as equivalence relations, binary relations, and 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 Contents

	Course Contents	Hours	CLOs
1.	**Groups**: Binary relation, Equivalence relation, Congruence modulo m, Semi group, Groups and their properties, Identity, Inverse and order of an element of a group, Order of an element of a group and Cyclic groups.	8 Hrs.	CLO1
2.	**Permutation Groups**: Permutation and their properties, Symmetric groups and alternative groups.	9 Hrs.	CLO1, CLO2
3.	**Subgroup:** Complex, Fundamental theorem of subgroup.	4 Hrs.	CLO3
4.	**Coset:** Product of cosets and Lagrange's theorem.	8 Hrs.	CLO4

5.	**Normal Subgroups**: Quotient groups and Centre of a group.	7 Hrs.	CLO4, CLO5
6.	**Homomorphism**: Automorphism, Homomorphism and isomorphism of group and their properties, Kernel of homomorphism, Fundamental theorems of homomorphism.	6 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO2	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO3	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	-	-	-	-
CLO5	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-

♦: Aligned -: Non-aligned

Learning Materials

Recommended Readings

i.	**Nicholson W. K**., Introduction to Abstract Algebra, Second edition*, J. Wiley,* 1999.
ii.	**Artin M.,** Algebra, *Pearson,* 2010.

Supplementary Readings

i.	**Awarwal R. S.,** A Text Book on Modern Algebra, S. Chand & Co., 2001.
ii.	**Bhattachary P. B., Jain J. K. and Paul S. R. N.,** Basic Abstract Algebra, Cambridge University Press, 1995.
ii.	**Khanna M. L.,** Abstract Algebra.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz and Mid-Semester
CLO2	Lecturing and Discussion	Mid-Semester and Summative
CLO3	Lecturing and Slide Presentation	Homework and Summative
CLO4	Visual Presentation and Discussion	Summative Exam
CLO5	Lecturing and Questioning and Answer Questioning	Mid-Semester and Summative

Course Title	Partial Differential Equations	**ISCED Code**	0541-313
		Course Code	MTH 313
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	03
Prerequisite	Calculus, Ordinary Differential Equations	**Total Marks**	100

Course Description

Partial Differential Equations (PDEs) is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. This is the introductory graduate course. Partial Differential Equations have an enormously vast field and essential tools for studying problems in many areas of mathematics, in particular in Mathematical Physics, Geometry and Applied Mathematics.

Rationale

This course is designed to provide the fundamental concept of differential equations and know the solution procedure of different mathematical problems involving these types of equations.

Course Objectives

This course will be helpful in understanding the basic concept of partial differential equations. By studying this, we can solve the of linear and non-linear different-order partial differential equations. Different-order and higher-order linear and non-linear partial differential equations can be analyzed and applied.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Formulate different types differential equations.
CLO2	Distinguish between ordinary and partial, linear and non-linear differential equations.
CLO3	Understand the different techniques to solve linear and non-linear partial equations and apply geometrical representation of different solutions of PDEs.
CLO4	Illustrate the physical interpretation of higher orderPDEs and Apply and Analyze the solutions of the higher order PDEs.
CLO5	Understand the Fourier method and its application to solve boundary value problem and Understand the Laplace transformation and its application to solve boundary value problem.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction of PDEs:** Basic concepts and formation of partial differential equations by different techniques.	3 Hrs.	CLO1, CLO2
2.	**First Order Equations:** Complete integral, General solution, Cauchy problems, Method of characteristics for linear and quasilinear equations and basic concepts on solutions techniques of linear partial differential equations.	4 Hrs.	CLO1, CLO2
3.	**Lagrange Method:** Technique to find the complete solution of linear PDEs by Lagrange's method (including different cases), Surface integral.	7 Hrs.	CLO2, CLO3
4.	**Nonlinear PDEs:** Compatibility and solution of NPDEs by Charpit's method for finding complete, singular and general integrals.	7 Hrs.	CLO2, CLO3 CLO4, CLO5

5.	**Canonical Transformation:** Second Order equations, Classifications, Reduction to canonical forms, Characteristic curves, and Boundary value problem: related to linear equations, Applications of Fourier methods (Coordinate systems and separability, Homogeneous equations, Non-homogeneous boundary conditions, Inhomogeneous equations).	11 Hrs.	CLO3, CLO4 CLO5
6.	**Boundary Value problem:** 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.	10 Hrs.	CLO3, CLO4 CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

CLOs/ PLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	♦	-	-	♦	♦	-	-	-	-	-	-	-
CLO3	-	♦	♦	-	♦	♦	♦	-	-	-	-	-
CLO4	-	♦	♦	♦	♦	♦	-	-	-	-	-	-
CLO5	-	♦	♦	♦	♦	♦	-	♦	♦	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Zachmann D. W., and DuChateau P.,**Partial Differential Equations, *McGraw Hill,* Third edition, 2011.
ii.	**Raisinghania M. D.,** Ordinary and Partial Differential Equations, *S. Chand,* 2004.

Supplementary Readings

i.	**Strogatz S. H.,** Nonlinear Dynamics and Chaos, *West view Press,* 1994.
ii.	**Hinze J O.,** Turbulence, *McGraw Hill,* 1975.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz and Summative
CLO2	Lecturing and Discussion	Mid-Semester and Summative
CLO3	Student Activity and Discussion	Assignment and Summative
CLO4	Lecturing and Discussion	Assignment and Summative Exam
CLO5	Lecturing and Visual Presentation	Mid-Semester and Summative Exam

Course Title	Discrete Mathematics	**ISCED Code**	0541-314
		Course Code	MTH 314
Course Type	GED	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus, Real Analysis, Linear Algebra	**Total Marks**	100

Course Description

Discrete Mathematics is a GED course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and 4**2 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of functional analysis. However, it requires successful completion of **Calculus, Real Analysis and Linear Algebra.**

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, including irrational and rational numbers, are not discrete. As you know, between any two different real numbers, another real number is different from either. So they are packed without any gaps and cannot be separated from their immediate neighbours. 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 the relationships among them.

Course Objectives

The main objectives of this course is to develop logical thinking and its application to computer science (to emphasize the importance of proving statements correctly and de-emphasize the hand-waving approach towards the correctness of an argument). It will be covered the mathematical topics most directly related to computer science. Students will be solved problems which involve discrete data structures. To construct valid mathematical arguments (proofs) and understand/apply mathematical statements (theorems). Students will be applied basic counting principles to solve a variety of problems. Again students will be achieved sufficient knowledge to find the shortest path and construct the minimum spanning tree.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Construct simple mathematical proofs and possess the ability to verify
CLO2	Identify and apply basic concepts of proof techniques, binary relations, graphs and trees.
CLO3	Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.
CLO4	Make effective use of appropriate technology.
CLO5	Apply the mathematical concepts learned to various areas of computer science.

Course Contents

	Course Contents	Hours	CLOs
1.	**Mathematical Reasoning:** Logic, Inference and fallacies, Methods of proof, Recursive definitions and Program verification.	10 Hrs.	CLO1, CLO2, CLO3

2.	**Combinatorics:** Counting principles, Inclusion-exclusion principle, Pigeonhole principle, Generating functions, Recurrence relations and Applications to computer operations	10 Hrs.	CLO1, CLO2 CLO3, CLO4
3.	**Algorithms on Graphs:** Introduction to graphs, Paths and trees, Shortest path problems (Dijkstra'a algorithm, Floyd-Warshall algorithm and their comparisons), Spanning tree problems (Kruskal's greedy algorithm, Prim's greedy algorithm and their comparisons).	12 Hrs.	CLO1, CLO3, CLO5
4.	**Network Flows:** Flows and cuts, Flow augmentation algorithm, Application of Max-flow min-cut theorem.	10 Hrs.	CLO2, CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO2	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO3	♦	♦	-	♦	♦	♦	♦	♦	♦	♦	-	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	-	♦	-	-
CLO5	♦	♦	-	♦	♦	♦	♦	♦	-	♦		-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Rosen K. H.,** Discrete Mathematics and its Applications, *McGraw Hill,* 2011.
ii.	**Lipschutz S., and Lipson M.,** Discrete Mathematics, *Schaumes Outline series,*2009.

Supplementary Readings

i.	**Kolman B., Busby R. and Ross S. C.,** Discrete Mathematical Structures, *Pearson,* 2008.
ii.	**Grimaldi R. P. and Ramana B. V.,** Discrete and Combinatorial Mathematics, *Pearson,* 2008.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Discussion	Presentation and Mid-Semester
CLO2	Lecturing and Visual Presentation	Assignment and Mid-Semester
CLO3	Lecturing and Student Activity	Homework and Summative
CLO4	Lecturing and Slide Presentation	Summative Exam
CLO5	Lecturing and Questioning and Answer Questioning	Presentation and Summative

Course Title	Data Structures and Algorithms	**ISCED Code**	0741-315
		Course Code	CSE 315
Course Type	GED	**Course Status**	Theory
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Programming with C and C++	**Total Marks**	50

Course Description

Data Structure and Algorithms is a theory GED course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credits** and **28 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. The course emphasizes solving real-world problems by implementing various data structures and algorithms, utilizing C/C++ programming languages alongside concurrent courses.

Rationale

The theory enables students to apply the acquired knowledge to solve real-world problems. Students develop the skills to analyze, design, and optimize solutions for various computational challenges by implementing different data structures and algorithms. Students enhance their programming skills through lab work and programming tasks, particularly in languages like C/C++. They learn to write efficient and effective code, debug and troubleshoot errors, and gain proficiency in utilizing programming constructs specific to data structures and algorithms. The lab nurtures students' problem-solving abilities by presenting diverse programming challenges. By tackling these problems using appropriate data structures and algorithms, students develop critical thinking, logical reasoning, and analytical skills.

Course Objectives

The theory course aims to strengthen students' problem-solving skills. By applying various data structures and algorithms to solve programming problems, students learn how to analyze problems, design appropriate solutions, and optimize algorithms for better efficiency. Students learn to evaluate the advantages and disadvantages of different data structures and algorithms, making informed decisions about their application in specific scenarios. Through practical application, students deepen their understanding of topics such as linked lists, stacks, queues, trees, sorting algorithms, searching algorithms, and more.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Demonstrate a thorough understanding of fundamental data structures and algorithms, including but not limited to linked lists, stacks, queues, trees, sorting algorithms, and searching algorithms and Differentiate between graphs and trees and make graphs/trees when these are best suited for manipulating the data.
CLO2	Implement data structures and algorithms using programming languages like C/C++, ensuring correctness, efficiency, and proper memory management and Analyze algorithms' time and space complexity, and make informed decisions on their suitability for specific problem-solving scenarios.
CLO3	Demonstrate proficiency in debugging and troubleshooting skills to identify and resolve errors in data structure and algorithm implementations and Collaborate effectively with peers in group programming exercises, demonstrating teamwork and communication skills in problem-solving scenarios.
CLO4	Critically evaluate the strengths and weaknesses of different data structures and algorithms, and select the most appropriate ones for solving specific computational problems and Utilize appropriate tools and software libraries to aid in implementing and visualizing data structures and algorithms.
CLO5	Apply appropriate data structures and algorithms to solve various programming problems, considering factors such as efficiency, scalability, and code readability and Design data structures to store and manipulate data while solving real life problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction:** Concept and importance of data, Data structure, Relation between the data structure and algorithm (program), Major operations on the data structure, Implement some elementary programs where different data types are used.	4 Hrs.	CLO1, CLO3, CLO5
2.	**Array:** Implementation of searching, Insertion, and merging operations using a one-dimensional array, Implementation of some algorithms where two-dimensional arrays are used.	4 Hrs.	CLO1, CLO3, CLO5
3.	**Linked List:** Implement algorithms to add a node to a different place of linear and doubly linked lists, Singly Linked list, Doubly link list, Traversal, Insertion, Deletion, and Modification.	4 Hrs.	CLO1, CLO3, CLO4, CLO5
4.	**Stack and Queue:** Basic stack operations (push/pop/peek), Stack-class implementation using array and linked list, In-fix to post-fix expressions conversion and evaluation, Balancing parentheses using stack, Basic queue operations (enqueue, dequeue), Circular queue/ dequeue, queue-class implementation using array and linked list,application-Josephous problem, Palindrome checker using stack and queue.	5 Hrs.	CLO1, CLO3, CLO4, CLO5
5.	**Binary Tree (BIT):** Binary tree representation using array and pointers, Traversal of binary tree (inorder, pre-order and post-order), Binary index tree, Segment tree, Range Minimum Query (RMQ), Improvement of BIT: AVL Tree. **Graph:** Graph representation (adjacency matrix/adjacency list), Basic operations on graph (node/edge insertion and deletion), Traversing a graph: Breadth-first search (BFS), Depth-first search (DFS), Topological Sort.	5 Hrs.	CLO2 CLO3, CLO4, CLO5
6.	**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.	3 Hrs.	CLO1, CLO3, CLO4, CLO5
7.	**Algorithm analysis and Designing:** Basic concept and importance**,** Complexity and space complexity**,** Growth functions, O, Ω and θ notations, Recurrences, Divide and Conquer, Greedy method, Dynamic programming, and Backtracking.	3 Hrs.	CLO1, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	♦	-	♦	-	-	♦	-	♦	♦	-	-
CLO2	-	♦	-	-	♦	-	♦	-	♦	♦	-	-
CLO3		♦	-	♦	♦	-	♦	-	-	-	-	-
CLO4	-	♦	-	♦	♦	-	♦	-	♦	♦	-	-
CLO5	-	♦	-	-	♦	-	♦	-	♦	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Thomas H. C., Charles E. L., Ronald L. R., and Stein C.,** Introduction to Algorithms*, The MIT Press,* 2009.
ii.	**Sedgewick R., and Wayne K.,** Algorithms, *Addison-Wesley Professional*, 2011.

Supplementary Readings

i.	**Lipschutz S.,** Data Structures, *Schaum's Outlines Series,* 2017.
ii.	**Knuth D.E.,** Art of Programming, Volume 1: Fundamental Algorithms, *Edison Wisely*, 2015.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Visual Presentation	Quiz (Formative) and Mid-Semester (Summative)
CLO2	Lecturing and Student Activity	Homework(Formative) and Summative
CLO3	Lecturing and Group Discussion	Mid-Semester and Summative
CLO4	Lecturing and Slide Presentation	Mid-Semester and Summative
CLO5	Slide Presentation and Questioning and Answer Questioning	Homework and Final Exam (Summative)

Course Title	Data Structures and Algorithms Lab	**ISCED Code**	0741-316
		Course Code	CSE 316
Course Type	GED	**Course Status**	Lab
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Programming with C and C++	**Total Marks**	50

Course Description

Data Structure and Algorithms Lab is a GED Lab course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credit** and **28 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. The course emphasizes solving real-world problems by implementing various data structures and algorithms, utilizing C/C++ programming languages alongside concurrent courses.

Rationale

The lab enables students to apply the acquired knowledge to solve real-world problems. Students develop the skills to analyze, design, and optimize solutions for various computational challenges by implementing different data structures and algorithms. Students enhance their programming skills through lab work and programming tasks, particularly in languages like C/C++. They learn to write efficient and effective code, debug and troubleshoot errors, and gain proficiency in utilizing programming constructs specific to data structures and algorithms. The lab nurtures students' problem-solving abilities by presenting diverse programming challenges. By tackling these problems using appropriate data structures and algorithms, students develop critical thinking, logical reasoning, and analytical skills.

Course Objectives

The lab course aims to strengthen students' problem-solving skills. By applying various data structures and algorithms to solve programming problems, students learn how to analyze problems, design appropriate solutions, and optimize algorithms for better efficiency. Students learn to evaluate the advantages and disadvantages of different data structures and algorithms, making informed decisions about their application in specific scenarios. Through practical application, students deepen their understanding of topics such as linked lists, stacks, queues, trees, sorting algorithms, searching algorithms, and more.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Demonstrate a thorough understanding of fundamental data structures and algorithms, including but not limited to linked lists, stacks, queues, trees, sorting algorithms, and searching algorithms.
CLO2	Differentiate between graphs and trees and make graphs/trees when these are best suited for manipulating the data.
CLO3	Implement data structures and algorithms using programming languages like C/C++, ensuring correctness, efficiency, and proper memory management.
CLO4	Analyze algorithms' time and space complexity, and make informed decisions on their suitability for specific problem-solving scenarios and Design data structures to store and manipulate data while solving real life problems.
CLO5	Demonstrate proficiency in debugging and troubleshooting skills to identify and resolve errors in data structure and algorithm implementations and Apply appropriate data structures and algorithms to solve various programming problems, considering factors such as efficiency, scalability, and code readability.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction:** Concept and importance of data, Data structure, Relation between the data structure and algorithm (program), Major operations on the data structure, Implement some elementary programs where different data types are used.	2 Hrs.	CLO1, CLO3, CLO5
2.	**Array:** Implementation of searching, Insertion, and merging operations using a one-dimensional array, Implementation of some algorithms where two-dimensional arrays are used.	2 Hrs.	CLO1, CLO3, CLO5
3.	**Linked List:** Implement algorithms to add a node to a different place of linear and doubly linked lists, Singly Linked list, Doubly link list, Traversal, Insertion, Deletion, and Modification.	4 Hrs.	CLO1, CLO3, CLO4, CLO5
4.	**Stack and Queue:** Basic stack operations (push/pop/peek), Stack-class implementation using array and linked list, In-fix to post-fix expressions conversion and evaluation, Balancing parentheses using stack, Basic queue operations (enqueue, dequeue), Circular queue/ dequeue, queue-class implementation using array and linked list,application-Josephous problem, Palindrome checker using stack and queue.	4 Hrs.	CLO1, CLO3, CLO4, CLO5
5.	**Binary Tree (BIT):** Binary tree representation using array and pointers, Traversal of binary tree (inorder, pre-order and post-order), Binary index tree, Segment tree, Range Minimum Query (RMQ), Improvement of BIT: AVL Tree. **Graph:** Graph representation (adjacency matrix/adjacency list), Basic operations on graph (node/edge insertion and deletion), Traversing a graph: Breadth-first search (BFS), Depth-first search (DFS), Topological Sort.	5 Hrs.	CLO2 CLO3, CLO4, CLO5
6.	**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.	2 Hrs.	CLO1, CLO3, CLO4, CLO5
7.	**Algorithm analysis and Designing: Basic concept and importance,** Complexity and space complexity**,** Growth functions, O, Ω and θ notations, Recurrences, Divide and Conquer, Greedy method, Dynamic programming, and Backtracking.	2 Hrs.	CLO1, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	-	♦	-	♦	-	-	♦	-	♦	♦	-	-
CLO2	-	♦	-	-	♦	-	♦	-	♦	♦	-	-
CLO3	-	♦	-	♦	♦	-	♦	-	-	-	-	-
CLO4	-	♦	-	♦	♦	-	♦	-	♦	♦	-	-
CLO5	-	♦	-	-	♦	-	♦	-	♦	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Thomas H. C., Charles E. L., Ronald L. R., and Stein C.,** Introduction to Algorithms*, The MIT Press,* 2009.
ii.	**Sedgewick R., and Wayne K.,** Algorithms, *Addison-Wesley Professional*, 2011.

Supplementary Readings

i.	**Lipschutz S.,** Data Structures, *Schaum's Outlines Series,* 2017.
ii.	**Knuth D.E.,** Art of Programming, Volume 1: Fundamental Algorithms, *Edison Wisely*, 2015.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Group Discussion	Quiz and Mid-Semester
CLO2	Lecturing and Student Activity	Homework and Summative
CLO3	Lecturing and Discussion	Mid-Semester and Summative
CLO4	Lecturing and Slide Presentation	Mid-Semester and Summative
CLO5	Lecturing and Student Activity	Presentation and Final Exam (Summative)

Third Year Second Semester

Course Title	Complex Analysis II	**ISCED Code**	0541-321
		Course Code	MTH 321
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./week	**Credit Value**	3.0
Prerequisite	Fundamentals of Mathematics, Calculus and Real Analysis.	**Total Marks**	100

Course Description

Complex Analysis II is a major/compulsory/core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for learning the complex analysis. However, it requires successful completion of **Fundamentals of Mathematics**, **Calculus and Real Analysis** courses.

Rationale

Complex functions have numerous applications in areas such as engineering, physics, differential equations and number theory, to name just a few. This course focuses on studying holomorphic functions and their most critical basic properties. Topics covered are complex integration, Cauchy's integral formulae, the extension of Cauchy's integral formulae, some related theorems, Cauchy's inequality, Liouville's theorem, and fundamental theorem of algebra. Power series of complex terms; Tailor's and Laurent's expansion of complex functions, Taylor's theorem, poles and zeros of holomorphic functions, Residue theorems, conformal mappings, the physical significance of conformal mappings etc.

Course Objectives

This course is designed to introduce Cauchy's theorem, Cauchy's integral theorem, Cauchy's integral formulae, extension of Cauchy's integral formulae, Liouville's theorem, fundamental theorem of algebra, Gauss mean value theorem, maximum modulus theorem and minimum modulus theorem. Students will learn about the power series, Tailor's and Laurent's expansion of complex functions, singularities, poles and zeros of holomorphic functions; Residue theorems, the argument theorems and their extension, Weierstrass theorem, and Rouche's theorem. They will also be able to evaluate contour integration over the complex plane. Students understand the ideas of conformal mapping and bilinear transformation.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts and fundamental principles ofcomplex integration.
CLO2	Apply the concept of limit, Continuity, Differentiability and analyticity of complex functions, Categorize and integrate the complex functions by line integrals Cauchy's integral formulae and their consequence.
CLO3	Familiarity with the different theorems, independently prove, Analyze and thoroughly explain the fundamental results of those theorems in the field of engineering and Interpret the analyticity, different types of singularities, application of Laurent series, Difference between Laurent series and Taylor series expansion.
CLO4	Build a strong foundation in conformal mappings, bilinear transformations and their properties and finally comparison all the applications with real analysis and complex analysis.
CLO5	Evaluate integrals and sum series by the use of different theorems and Explain the residue of a function and use the residue, applications of related theorems in complex plane and evaluate a contour integral or an integral over the complex plan.

Course Contents

	Course Contents	Hours	CLOs
1.	**Cauchy's Integral Formula and Related Theorems**: Cauchy's integral formulae, Extension of Cauchy's integral formulae, Some Related theorems, Cauchy's Inequality, Liouville's theorem, Fundamental theorem of algebra, Gauss mean value theorem, Maximum modulus theorem and minimum modulus theorem.	8 Hrs.	CLO1, CLO2
2.	**Infinite Series**: Taylor's series expansion, Laurent's series expansion.	4 Hrs.	CLO3 CLO4
3.	**Singularities**: Zero of a function, Singular points, Different types of singularities, Poles and zeros are Isolated, Limit points of Zero and poles, Memomorphic functions, Working rules for poles and singularities, The argument theorems and its extension, Weierstrass theorem and Rouche's theorem.	10 Hrs.	CLO1, CLO3 CLO4
4.	**The Calculus of Residues**: Residues, Cauchy's residue theorem, Evaluation of Definite integrals, Theorems used in evaluating Integrals, Integration round the cut circle, Improper integration involving sines and cosines, Integrals by contour integrations, Branch points, Branch lines and cuts, Integration through branch cut and Related contours.	10 Hrs.	CLO3, CLO4
5	**Bilinear Transformation and Conformal Mapping**: Transformations, Jacobian of a transformation, Conformal mappings, Simple functions, Some general transformation, The Linear transformation, Successive Transformation, Bilinear transformations, Mapping of a half plane onto a circle, The Schwarz-Christoffel transformation and Applications of conformal mapping.	10 Hrs.	CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	-	-	-	♦	♦	♦	♦	♦	-	-
CLO3	♦	♦	♦	♦	♦	♦	_	♦	_	_	_	_
CLO4	♦	-	♦	-	-	♦	-	♦	-	-	♦	♦
CLO5	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Charchill R. V.,** Complex Variable and Application,*McGraw Hill*, 2013.
ii.	**Spiegel M. R.,** Complex Variable, *McGraw Hill*, 2009.

Supplementary Readings

i.	**Choudhary B.,** The Elements of Complex Analysis, *Wiley***,** 1983.
ii.	**Zill D. G. and Shanahan P. D.,**A first course in complex analysis with applications, *Jones and Bartlett Publishers*, 2003.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Student Activity	Quiz and Mid-Semester
CLO2	Lecturing and Group Discussion	Mid-Semester and Summative
CLO3	Lecturing and Visual Presentation	Mid-Semester and Summative
CLO4	Lecturing and Group Discussion	Summative Exam
CLO5	Lecturing and Student Activity	Summative Exam

Course Title	Abstract Algebra II	**ISCED Code**	0541-322
		Course Code	MTH 322
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	3.0
Prerequisite	Complex Analysis, Linear Algebra and Real Analysis and Group Algebra	**Total Marks**	100

Course Description

Abstract Algebra II is a core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of rings and fields and their structures. However, it requires successfully completing **Complex Analysis, Linear Algebra, Real Analysis and Group Algebra.**

Rationale

Abstract Algebra II are the topics of Algebra that deal with abstract algebraic structures rather than the usual number systems. It aims to find general underlying principles common to the usual operations (addition, multiplication, etc.) on diverse sets such as integers, polynomials, matrices, permutations, and much more. Students will learn, in particular, about the most important abstract algebraic structures: rings and fields. It gives the students good mathematical maturity and enables them to build mathematical thinking and skill.

Course Objectives

Introduce students to the basic concepts of algebraic structures embedded in Ring theories. Capture the canonical homomorphism via normality leading to isomorphism of two rings. Upon completion of this course, students may take Advanced Abstract Algebra or Graph Theory with applications.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Describe Rings, subrings, ideals.
CLO2	Explain abstract algebraic construction of number sets and operations and see from where the constructs derive and Differentiate between different structures and understand how changing properties give rise to new structures.
CLO3	Describe Integral domains, division rings, fields, quotient rings and Understand principal ideal domains, Euclidean domains, unique factorization domains.
CLO4	Justify the concepts of isomorphism and homomorphism and Explain the proofs of propositions arising in the context of Abstract Algebra.
CLO5	Define Characteristic of an integral domain. Prime Fields, structure of prime fields, extension field apply the abstract algebra in real-world life.

Course Contents

	Course Contents	Hours	CLOs
1.	**Rings**: Rings, Various types of rings, Properties of rings, Subrings, Integral domains, Division rings, Fields and Quotient rings.	4 Hrs.	CLO1,CLO2
2.	**Ideals**: Ideals, Principal ideals, Prime ideals and Maximal ideals.	8 Hrs.	CLO2, CLO3, CLO4
3.	**Factorization in Integral Domain:** Divisibility, Units, Associates, Highest common factor (HCF), Least common multiple (LCM), Coprimes, Prime elements, Irreducible elements, Principal ideal domains and Euclidean domains.	8 Hrs.	CLO2, CLO5

4.	**Polynomial Rings:** Polynomial and their properties,Reducible andIrreducible polynomials, Unique factorization domains.	8 Hrs.	CLO1, CLO2, CLO4
5.	**Homomorphism**: Automorphism, Homomorphism, Isomorphism of ring and their properties, Kernel of homomorphism and Fundamental theorem of homomorphism.	8 Hrs.	CLO3, CLO5
6.	**Prime Fields**: Structure of prime fields and Extension of fields.	6 Hrs.	CLO1, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

CLOs/ PLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	♦	-	♦	-	-	-	-
CLO2	♦	♦	-	♦	♦	♦	-	♦	-	-	-	-
CLO3	♦	♦	-	♦	♦	♦	-	♦	-	-	-	-
CLO4	♦	♦	♦	♦	♦	♦	-	♦	-	-	-	-
CLO5	♦	♦	-	♦	♦	♦		♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Nicholson W. K.,** Introduction to Abstract Algebra, Second edition*, J. Wiley,* 1999.
ii.	**Mecoy N. H.,** Introduction to Modern Algebra, *William C Brown Pub.,* 1992.

Supplementary Readings

i.	**Awarwal R. S.,** A Text Book on Modern Algebra, S. Chand & Co., 2001.
ii.	**Kuddus D., and Rahman M. M.,** Modern Algebra.
iii.	**Khanna M. L.,** Abstract Algebra.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz and Mid-Semester
CLO2	Lecturing and Group Discussion	Presentation and Mid-Semester
CLO3	Lecturing and Slide Presentation	Homework and Summative
CLO4	Lecturing and Visual Presentation	Summative Exam
CLO5	Lecturing and Questioning and Answer Questioning	Homework and Summative Exam

Course Title	Fuzzy Mathematics	**ISCED Code**	0541-323
		Course Code	MTH 323
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./week	**Credit Value**	3.0
Prerequisite	Fundamental of Mathematics, Basic Algebra, Set theory and Logic.	**Total Marks**	100

Course Description

Fuzzy Mathematics is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. **Fuzzy Mathematics** is more or less uncertain, vague and ambiguous. Fuzzy mathematics are powerful mathematical tools for modelling, uncertain systems in industry, nature and humanity; and facilitators for common-sense reasoning in decision-making in the absence of complete and precise information. Their role is significant when applied to complex phenomena not easily described by traditional mathematical methods, especially when the goal is to find a good approximate solution.

Rationale

Fuzzy Mathematics course about the fuzzy set, which is a bit different from the classical set. It has remarkable applications in various sector of science. 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 generalization of abstract set theory. Because of the generalization, it has a much broader 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.

Course Objectives

Fuzzy Mathematics gives the idea of fuzzy sets, operations on them, and notion of fuzzy logic to understand the difference between classical set theory and fuzzy set theory. It gives the idea of the relationship between classical sets and fuzzy sets via alpha-cut and strong alpha-cut representation, the convexity of fuzzy sets, and the Extension Principle for fuzzy sets. It also gives the notion of fuzzy numbers, arithmetic operations on them, and Lattice of fuzzy Numbers, the idea of linear fuzzy equations, the concept of fuzzy relations and operations, similarity fuzzy relation, fuzzy morphism, and fuzzy relation equation and the idea of the applications of fuzzy set theory.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Gather Knowledge about elementary concepts including basic types of fuzzy sets and Meaning and significance of the emergence of fuzzy set theory.
CLO2	Connect between fuzzy set and crisp set and describe how classical mathematical function can be fuzzified and Deal with the various aggregation operations on fuzzy set.
CLO3	Clearly describe fuzzy number and compute arithmetic operations in fuzzy numbers and Examine the linguistic variables and fuzzy equation.
CLO4	Study on various fuzzy relation and fuzzy relation equation and Deals with possibility theory and its intimate connection with fuzzy set theory.
CLO5	Gather knowledge about necessary and sufficient condition of a fuzzy set to be a fuzzy number and Achieve the idea of applications of fuzzy set theory and learn the methodology.

Course Contents

	Course Contents	Hours	CLOs
1.	**Fuzzy Sets:** Notion of Fuzzy sets, Operations of fuzzy sets, Fuzzy complement, Fuzzy union, Fuzzy intersection, combinations of operations, Cuts, and Representation theorem.	15 Hrs.	CLO1, CLO2,
2.	**Fuzzy Arithmetic:**Fuzzy numbers, Arithmetic operations on intervals and fuzzy numbers, Lattice of fuzzy numbers, and Fuzzy equations.	15 Hrs.	CLO1, CLO3, CLO4, CLO5
3.	**Fuzzy Relations:** Equivalence and similarity relations, Compatibility or tolerance relations, Orderings, Morphisms and Fuzzy relational equations.	12 Hrs.	CLO1, CLO2, CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	♦	♦	♦	♦	-	♦	-	-	♦	♦
CLO2	♦	-	♦	-	-	♦	♦	♦	-	-	♦	♦
CLO3	♦	♦	♦	♦	♦	-	♦	-	♦	-	-	-
CLO4	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
CLO5	♦	-	-	♦	-	-	♦	-	♦	♦	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Klir G. J., Clair U. S., and YuanB.,** Fuzzy Set theory-Fundamental & Applications, *Prentice Hall*, 1997.
ii.	**Klir G. J. and Yuan B.,** Fuzzy sets & Fuzzy logics-Theory & Applications, *Prentice-Hall of India Pvt. Ltd.*, 2008.

Supplementary Readings

i.	**Zimmermann H. J.**, Fuzzy Set Theory and Its Applications, *Springer Dordrecht,* 2012.
ii.	**Lowen R.,** Fuzzy Set Theory: Basic concepts, Techniques and Bibliography, *Springer*, 1996.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Group Discussion	Quiz and Mid-Semester
CLO2	Lecturing and Student Activity	Mid-Semester and Summative
CLO3	Lecturing and Group Discussion	Presentation and Summative
CLO4	Lecturing and Slide Presentation	Homework and Summative
CLO5	Lecturing and Questioning and Answer Questioning	Assignment and Summative

Course Title	Mathematical Methods	**ISCED Code**	0541-324
		Course Code	MTH 324
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Ordinary Differential Equations	**Total Marks**	100

Course Description

Mathematical Methods is a compulsory course for the students of the B. Sc. (Honours) program. The course carries **3.0 credits** and **42 hours** of effective class teaching. 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

Mathematical Methods appear as solutions of differential equations and integrals of special functions. Therefore, this course provides most important integrals; at least, the integral representation of special functions. Because symmetries of differential equations are essential to both physics and mathematics, Mathematical Methods is closely related to certain topics in mathematical physics.

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 2nd 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)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Introduce the concept of the Fourier series and discuss its different properties.
CLO2	Apply the Fourier series to solve both the second order ordinary and partial differential equations.
CLO3	Introduce the concept of Fourier transforms and discuss its different properties and Apply the Fourier transform to solve the second order partial differential equations such as heat, wave and Laplace equation.
CLO4	Introduce the concept of Laplace transforms and discuss its different properties and Apply the method of Laplace transform to solve both the ordinary and partial differential equations that arise in the science and engineering field.
CLO5	Introduce Sturm-Liouville boundary value problems, solution by Eigen function expansion and Green's functions.

Course Contents

	Course Contents	Hours	CLOs
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.	9 Hrs.	CLO1, CLO2
2.	**Fourier Transforms**: Fourier transforms, Inversion theorem, sine and cosine transforms, Transform of derivatives, Transforms of rational function, Convolution theorem, Parseval's theorem, Applications to boundary value problems and integral equation.	12 Hrs.	CLO2, CLO3, CLO4

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 to boundary value problems related to PDEs.	12 Hrs.	CLO4, CLO5
4.	**Eigenvalue Problems and Sturm-Liouville Boundary Value Problems:**Regular Sturm-Liouville boundary value problems, Nonhomogeneous boundary value problems and the Fredholm alternative, Solution by Eigen function expansion, Green's functions, Singular Sturm-Liouville boundary value problems/Oscillation and comparison theory.	9 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	♦	-	♦	-	-	♦	-
CLO2	♦	♦	-	♦	♦	♦	♦	♦	♦	♦	-	♦
CLO3	♦	-	♦	♦	-	♦	-	-	-	-	♦	-
CLO4	♦	♦	-	♦	♦	♦	♦	♦	♦	♦	-	♦
CLO5	♦	-	♦	♦	-	-	-	-	♦	-	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Spiegel M. R.,** Laplace Transforms, *Schaum's Outline Series,McGraw Hill,* 1965.
ii.	**Churchill R. V., and Brown J. W.**, Fourier Series and Boundary value problems, *McGraw Hill,* 1941.

Supplementary Readings

i.	**Lebedev J. W., and Silverman R.A.**, Special Functions and their Applications, *Dover Publications,* 1972
ii	**Kreyszig E.,** Advanced Engineering Mathematics, *Wiley,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz and Mid-Semester
CLO2	Lecturing and Student Activity	Homework and Mid-Semester
CLO3	Lecturing and Group Discussion	Mid-Semester and Summative
CLO4	Lecturing and Slide Presentation	Summative Exam
CLO5	Lecturing and Student Activity	Assignment and Summative

Course Title	Theory of Numbers	**ISCED Code**	0541-325
		Course Code	MTH 325
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus, Linear Algebra and Real Analysis and Abstract Algebra	**Total Marks**	100

Course Description

Theory of Numbers is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory group and their structures. However, it requires successful completion of **Calculus, Linear Algebra and Real Analysis and Abstract Algebra.**

Rationale

The **Theory of Numbers** is devoted primarily to studying integers, one of the oldest and most beautiful areas of Pure Mathematics. It is sometimes called The Queen of Mathematics. Many problems in number theory can be formulated in a relatively simple language. Its application is to the cryptographic systems allowing banks, commercial companies, military establishments, and so on to exchange information securely encoded. Students will become familiar with the notion of formal proof in a concrete setting rather than as an abstract exercise in logic.

Course Objectives

This course provides students with a sound foundation in Number Theory from a modern perspective. It presents a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs. The main objective of this course is to give a self-contained module with modern answers to ancient problems and modern applications of classical ideas.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Describe the relation between GCD and LCM and their properties.
CLO2	Define the basic arithmetic of the number system, fundamental theorem of arithmetic.
CLO3	Explain some important theorem such as Fermat's theorem, Euler's theorem, Wilson's theorem, Lagrange theorem etc.
CLO4	Write the definition of Euler's ϕ- function and its expression in terms of prime factors and Justify with linear congruences and know the Chinese remainder theorem.
CLO5	Explain the order of a number with respect to a relatively prime modulus will understand and Represent the integers by sum of squares.

Course Contents

	Course Contents	Hours	CLOs
1.	Divisibility, Division algorithm, Perfect number, Fermat number, Number of divisors, Sum of divisors, Arithmetic in **Z**, Euclidean algorithm, Continued fractions and Linear Diophantine equations.	10 Hrs.	CLO1, CLO2 CLO3, CLO4
2.	Congruence, Fermat's Theorem, Euler's Extension, Wilson's and Lagrange's Theorem.	8 Hrs.	CLO2, CLO3, CLO4
3.	The ring Z_n and its group of units, Chinese remainder theorem.	8 Hrs.	CLO2, CLO4, CLO5

4.	Arithmetical functions, Dirichlet convolution, Multiplicative function, Representation by sum of two and four squares and Mobius inversion formula	8 Hrs.	CLO5
5.	Arithmetic of quadratic fields, Euclidean quadratic fields, Diophantine equation and the Fermat equation, two squares and four squares theorem.	8 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	♦	-	-	-	-	-	-
CLO2	♦	♦	-	♦	♦	♦	-	-	-	-	-	-
CLO3	♦	♦	-	♦	♦	♦	-	-	-	-	-	-
CLO4	♦	♦	♦	♦	♦	♦	-	-	-	-	-	-
CLO5	♦	♦	-	♦	♦	♦	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Hardy G. H., and Wright E. N.,** An Introduction to the Theory of Numbers, *Oxford University Press*, 2008.
ii.	**Burton D. M.**, Elementary Number Theory, *McGraw Hill,* 2010.

Supplementary Readings

i.	**Chowdhury M. R., and Chowdhury F.,** Essentials of Number Theory
ii.	**LeVeque W. J.,** Topics in Number Theory, Vol I & II, *Dover Publications,* 2002.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Group Discussion	Assignment and Presentation
CLO2	Lecturing and Student Activity	Homework and Mid-Semester
CLO3	Lecturing and Visual Presentation	Mid-Semester and Summative
CLO4	Lecturing and Student Activity	Presentation and Summative
CLO5	Lecturing and Questioning and Answer Questioning	Presentation and Summative

Course Title	Math Lab II: Basics Concept of MATLAB	**ISCED Code**	0541-326
		Course Code	MTH 326
Course Type	Core	**Course Status**	Lab
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Linear Algebra, Calculus, ODEs and Numerical analysis	**Total Marks**	100

Course Description

Math Lab-II: Basics Concept of MATLAB is a compulsory core laboratory course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credits** and **28 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is a mathematics simulation course for learning a programming language. However, it requires successful completion of **Advanced Calculus, Linear Algebra and Ordinary Differential Equations.**

Rationale

Math Lab-II: Basics Concept of MATLAB focuses to apply computational software: Mathematica/ MATLAB/Fortran, which is a high-performance language for technical computing where problems and solutions are expressed in familiar mathematical notation. The course allows the students to develop skills in programming languages and their proper uses.

Course Objectives

The main objectives of **Math Lab-II: Basics Concept of MATLAB** are to build and strengthen students' conceptual knowledge of functions, linear functions, equations, inequalities, exponential functions, systems of linear equations and inequalities, calculus of several variables, differential equations, numerical analysis and mathematical modelling. The course will further offer the knowledge of demonstrating, explaining and reinforcing abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, etc.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Describe computer methods for solving a wide range of engineering problems.
CLO2	Use graphical representation of different Mathematical problems.
CLO3	Exploit computer skills to enhance learning and performance in different mathematical courses.
CLO4	Write different codes for solving different types of scientific programming problems described in detail in the syllabus.
CLO5	Apply various simulations in to solve practical problems in diverse fields and Consolidate teamwork skills such as dividing tasks, being responsive, and taking responsibility for the work of the team.

Course Contents

	Course Contents	Hours	CLOs
1.	**Advanced Calculus:** Graphical representation of the function of several variables, Contour plot, Level curves, Domain and range, Limit and continuity, Partial Derivatives, Chain rules, Tangent plane and normal line, Directional derivatives, Optimization for MATLAB code, Double and triple integrals, Application multiple integrals.	9 Hrs.	CLO1, CLO2, CLO3, CLO5

2.	**Linear Algebra**: Matrix algebra, Inevitability, Vector space and Subspace, Basis and dimensions, The system of linear equations, Row space, Column space and Null space, Rank, and Nullity of a matrix.	7 Hrs.	CLO1, CLO2, CLO3, CLO4
3.	**Ordinary Differential Equations (ODEs):** Formulation of ODE, Solutions of first order first degree ODEs, First order higher degree ODE, Higher order linear homogeneous and non-homogeneous ODEs, The system of ODE and series solutions of linear ODE and Real-life applications of ODEs.	12 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	-	-	-	♦	-	-	-	♦	♦	-	_
CLO4	♦	♦	-	-	♦	♦	-	♦	-	♦	♦	-
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Lipsman R. L., and Rosenberg J. M.,** Multivariable Calculus with MATLAB®: With Applications to Geometry and Physics, *1st Edition, Springer,* 2017.
ii.	**Hunt B. R., Lipsman R. L., Osborn J. E., and Rosenberg J. M.,** Differential Equations with MATLAB, *10th Edition, Wiley,* 2019.
iii.	**Makiben M., and Webster M. D.,** Differential Equations with MATLAB Exploration, Applications and Theory, *CRC Press,* 2015.

Supplementary Readings

Supplementary Readings:	
1.	**Chapman S. J.,** MATLAB Programming for Engineers, *6th Edition, Cengage Learning,* 2019.
ii.	**Chapra S.,** Applied Numerical Methods with MATLAB for Engineers and Scientists, *5th Edition, McGraw Hill,* 2022.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Comprehensive Viva	**ISCED Code**	0541-399
		Course Code	MTH 399
Course Type	Core	**Course Status**	Oral/Presentation
Course Hour	---	**Credit Value**	2.0
Prerequisite	Recommended Books and Lecture Materials	**Total Marks**	100

Course Description

Comprehensive Viva is a major/compulsory/core course for undergraduate students of B. Sc. Students pursue a **2.0 credit** (Honors) program, requiring effective teaching in the first and second semesters. Course grades will be assessed through participation, class presentations, quizzes, and comprehensive examinations. However, it requires successful completion of all courses in the first and second semesters.

Rationale

Yearly Comprehensive viva gives students the opportunity to demonstrate their understanding of the subject and answer questions.

Course Objectives

This is a platform to practice and show their smartness and confidence, as well as to address immediate issues in the society.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Realize themselves through oral assessment that helps students develop valuable communication skills.
CLO2	Enable interactive dialogue between candidate and assessor, allowing the examinee to demonstrate strengths and letting examiners discriminate between superficial and real knowledge via in-depth questioning.
CLO3	Have the ability to tailor the questions asked to the needs of each individual.
CLO4	Assess on the spot. Recent years have seen this traditional form of assessment used mostly to defend different subjects.
CLO5	In order to discriminate among the top achieving students, higher order cognitive skills can be tested by in-depth questioning.

Course Contents

	Course Contents	Duration	CLOs
1.	Students respond orally to questions during the comprehensive viva examination. These tests frequently draw from both the first and second semesters' worth of coursework. A vital component of academic programs, viva exams are frequently administered at the end of each academic year.	First and Second Semester	CLO1, CLO2, CLO3, CLO4 CLO5
2.	These Viva examinations formed part of the theory component of the final summative examination in the second semester of the first year. Since the Viva Voce is conducted for all students irrespective of their passing status in theory, the exercise is time consuming. To determine the impact of viva voce examinations on summative examination performance, this study has been conducted.		

3.	The main focus of the assessment is on the written/ thesis/dissertation (and other outputs, for a Practice as Research students) in communicative English, basic computer knowledge, physics, statistics, algebra, geometry in two dimensions and differential calculus. Since mathematics is a fundamental subject, job-seeking students should investigate it at many organizations in the labor market. Viva voce is necessary to make mathematics appealing to the business and research fields.		

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	♦	-	♦	-	-	-	-
CLO2	♦	♦	♦	♦	-	-	-	-	-	-	-	-
CLO3	-	♦	-	♦	-	♦	♦	♦	♦	-	♦	-
CLO4	-	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦
CLO5	-	-	♦	-	-	-	-	-	♦	♦	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	All the recommended books of Third Year 1st and 2nd semester.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Discussion	Quiz and Assignment
CLO2	Lecturing and Discussion	Mid-Semester and Summative
CLO3	Lecturing and Discussion	Mid-Semester and Summative
CLO4	Student Activity and Discussion	Summative Exam
CLO5	Lecturing and Group Discussion	Presentation

Fourth Year First Semester

Course Title	General Topology	**ISCED Code**	0541-411
		Course Code	MTH 411
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Calculus, Real Analysis and Abstract Algebra	**Total Marks**	100

Course Description

General Topology is a major/compulsory/core course for undergraduate students in the B. Sc. (Honours) program. It carries **3.0 credits** and **42 hours** of effective teaching over **14 weeks**. Course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This course is an introductory course to advanced analysis. However, it requires **Calculus, Real Analysis, and Abstract Algebra.**

Rationale

General topology provide a framework for understanding the topological properties of spaces, such as connectedness, compactness, and continuity. These properties are essential for many areas of mathematics, including analysis, geometry, and algebraic topology.

Course Objectives

The main objective of the General Topology course is to provide a rigorous foundation for the study of topological space and its properties. This includes defining key concepts such as open sets, limits, continuity and convergences and developing methods for comparing and classifying topological spaces based on their properties. By studying General topology, students can develop a deep understanding of the structure and properties of topological spaces and apply this knowledge to a wide range of mathematical problems and applications.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Articulate the fundamental properties of metric spaces that are used in image processing to analyze and manipulate images.
CLO2	Understand the properties of topology, which are used in algorithms and data structures.
CLO3	Illustrate the compact spaces that play a key role in differential manifolds.
CLO4	Demonstrate the axiom separations, used in formal languages and automata theory.
CLO5	Apply the connected spaces used in graph theory and network analysis.

Course Contents

	Course Contents	Hours	CLOs
1.	**Metric Spaces:** Definition and examples, Open sets, Closed sets, Convergence, Completeness, Baire's theorem, Continuous mappings, Spaces of continuous functions, Euclidean and Unitary spaces.	6 Hrs.	CLO1
2.	**Topological Spaces:** Definition and examples, Elementary concepts, Bases and sub-bases, Weak topologies and Function algebra.	10 Hrs.	CLO2
3.	**Compactness:** Compact spaces, Product spaces, Tychonoff's theorem, Locally compact spaces and Compactness for metric spaces.	10 Hrs.	CLO3

4.	**Separation:** T_1-spaces and Hausdorff spaces, completely regular spaces and Normal spaces.	10 Hrs.	CLO4
5.	**Connectedness:** Connected spaces, locally connected spaces and Pathwise connectedness.	6 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	♦	♦	-	♦	-	♦	♦	-	-	-
CLO2	♦	♦	♦	♦	-	♦	♦	♦	♦	-	-	-
CLO3	♦	♦	♦	♦	-	♦	-	♦	♦	-	-	-
CLO4	♦	♦	♦	♦	-	♦	-	♦	♦	-	-	-
CLO5	♦	♦	♦	♦	-	♦	-	♦	♦	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Simmons G.F.,** Introduction to Topology and Modern Analysis, *Krieger Publishing Company*, 2003.
ii.	**Willard S.,** General Topology, *Dover Publications,* 2004.
iii.	**Chowdhury M. R., and Chowdhury F.,** Topology and Functional Analysis,
iv.	**Woddor I.,** Elements of Functional Analysis, *Cambridge University Press,* 1989.
v.	**Bradle T. D., Bryson T., and Terilla J.,** Topology: A Categorical Approach, *the MIT Press,* 2020.
vi.	**Baker C. W.,** Introduction to Topology, *Krieger Pub. Co.,* 1996.
vii.	**Singh T. B.,** Introduction to Topology, *Springer*, 2019.
viii.	**Yang C.-N., Ge M.-L., and He Y.-E.,** Topology and Physics,*WSPC,*2018.

Supplementary Readings

i.	**Lipschutz S.,** General Topology, *Schaum's Outline Series,* 2011.
ii.	**Prasolov V. V.,** Intuitive Topology.*American Mathematical Society***,** 1995.
iii.	**Weeks J R.,** The Shape of Space, *2nd ed. Marcel Dekker,* 2002.
iv.	**Moraleda R. R., Valous N., Xiong W., and Halama N.,** Computational Topology for Biomedical Image and Data Analysis: Theory and Applications, *CRC Press,* 2019.
v.	**Khanna M. L.,** Functional Analysis,
vi.	**Boules A. N,** Fundamental of Mathematical Analysis, *the Oxford University Press,* 2021.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing, Discussion and Student Activity	Presentation and Final Exam (Summative)

Course Title	Statics	**ISCED Code**	0541-412
		Course Code	MTH 412
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Statics is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. This is the introductory graduate course. Statics is an enormously vast field and an essential tool for studying problems in many areas of mathematics, particularly in Mathematical Physics, Geometry and Applied Mathematics.

Rationale

This course is designed to provide the fundamental concept of statics and know the solution procedure of different mathematical problems. Statics studies the equilibrium of rigid elements under the action of forces.

Course Objectives

This course contains for statics. By practicing this course, students can earn the basic concept of elementary statics. In this course, 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 related to the real-life matter in statics. One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is vital to problem formulation.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Can earn the knowledge on basic concept of statics.
CLO2	Know the reduction of coplanar forces, equilibrium of coplanar forces, resultant force, general condition of equilibrium, equation of resultant, a static equilibrium and its conditions, a staticcenter and problem solve.
CLO3	Distinguish between work and virtual work; know the procedureofforming the different equations of virtual work and solution.
CLO4	Know the different techniques to evaluate different formulae for the center of gravity by integration for any arc, area, surface of revolution and volumes also apply these formulae for different geometric bodies and proofs for known bodies and Know the different type of catenaries with some problem.
CLO5	Test the nature of equilibrium at different points of different shapes of bodies, able to find the coordinates ofequilibrium and earn the basic concepts of rectilinear motion (Simple harmonic motion).

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction:** Fundamental concepts and principles of Mechanics.	4 Hrs.	CLO1
2.	**Static of Particles:** Addition of forces, result of several concurrent forces, resolution of force in components, equilibrium of a particle in plane and in space. General conditions of equilibrium.	8 Hrs.	CLO1, CLO2
3.	Principle of virtual work,	6 Hrs.	CLO1, CLO3

4.	Centre of gravity.	4 Hrs.	CLO1, CLO4
5	Stable and unstable equilibrium.	8 Hrs.	CLO4, CLO5
7.	Equilibrium of flexible strings and Chains, Catenary, Common catenary.	8 Hrs.	CLO1, CLO5
8.	Rectilinear motion (Simple harmonic motion)	4 Hrs.	CLO1, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	_	-	-
CLO2	♦	-	♦	♦	-	-	-	_	_	_	-	-
CLO3	-	♦	♦	-	♦	♦	♦	-	-	-	_	_
CLO4	-	♦	♦	♦	-	♦	-	-	-	_	_	_
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	_	_	_

♦: Aligned -: Non-aligned

Learning Materials

Recommended Readings

i.	**Loney S. L,** An Elementary Treatise on Statics, *Cambridge University press*, 2016.
ii.	**Ramsey A. S.**, Statics, *CBS Publishers,* 2004.
iii.	**Yousuf M. A.,** Mechanics (Statics and Dynamics).

Supplementary Readings

i.	
ii.	
iii.	

Teaching-Learning andAssessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing and Discussion	Midterm (Summative)
CLO3	Lecturing and Discussion	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Tensor Analysis	**ISCED Code**	0541-413
		Course Code	MTH 413
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Vector Calculus, Geometry and Algebra	**Total Marks**	100

Course Description

Tensor Analysis is a major/compulsory/core course for the undergraduate. The course carries **3.0 creditsand 42 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. It requires successfully completion of **Algebra, Geometry, Trigonometry and Vector Calculus** courses.

Rationale

Tensor Analysis is important in many areas of mathematics, physics, mechanics, electromagnetic theory, aerodynamics, geophysics, meteorology or any of the numerous other fields in which tensor methods are applicable. Tensor algebra has become an essential part of the fundamental mathematical background required of those in engineering, sciences and allied disciplines. From this point of view, this course is designed for third-year students to impart valuable skills to enhance their mathematical ability in applying tensor techniques to solve problems in applied sciences and equip them with the necessary skill required to cope with higher-level courses in related subjects.

Course Objectives

The **Tensor Analysis** course aims to give students a strong foundation in the fundamental concepts of tensor algebra and calculus and their applications in physics, engineering, and mathematics. Upon completing this course, students will be able to develop a solid understanding of tensor algebra and calculus, including tensor transformation laws, the Einstein summation convention, and index notation. Apply tensor analysis to solve problems in classical mechanics, electromagnetism, and general relativity and understand the physical significance of tensors in these areas. Explore the concept of curvature and Riemannian geometry, and learn about the geometry of space-time in general relativity. Learn how tensors are used in machine learning, computer vision, and other modern applications. Enhance their problem-solving and critical-thinking skills by applying tensor analysis to real-world problems.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand tensor algebra and its applications in applied sciences and engineering.
CLO2	Know the fundamental mathematics of tensor that are important for higherlearning.
CLO3	Acquire working tools for some branchesof applied mathematics physics and geophysics.
CLO4	Develop ability to solvemathematical problems involving tensors and Understand rectangular, cylindrical and spherical co-ordinates and their translation
CLO5	Competentlyusetensoralgebraasatoolin the field of applied sciences and related fields and Apply tensor to diverse fields ofmathematics and physics, e.g., electromagnetism, general relativity theory, field theory and cosmology.

Course Contents

	Course Contents	Hours	CLOs
1.	**Basic Linear Algebra for Tensor:** Tensor and Coordinate transformations.	8 Hrs.	CLO1, CLO2

2.	**The Einstein Summation Convention**: Summation Convention, Space of N Dimensions, Covariant and Contravariant tensors.	8 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5
3.	**Tensor Operations:** Addition, Subtraction and Multiplication of Tensors, Contraction, Kronecker delta, Symmetric and Skew-symmetric Tensors and Quotient law.	4 Hrs.	CLO1, CLO3
4.	**Metric Algebra:** Outer Product and Inner Product of Tensors, Metric Tensor, Index Raising and Lowering, Concept of Length and Angles.	4 Hrs.	CLO4
5.	**The Derivation of Tensor:** Riemannian metric and Metric tensors, Conjugate and Associated Tensors, Christoffel's symbols and their Transformation laws.	6 Hrs.	CL03, CLO4, CLO5
7.	**Tensor in Classical Mechanics**: Geodesics and Parallelism**,** Covariant Derivative of a Vector and a Tensor, Intrinsic derivative, Tensor form of Gradient, Divergence and Curl.	6 Hrs.	CLO4, CLO5
8.	Sphere, Riemann Christoffel curvature tensor, Ricci Tensor, Bianchi identity, Flat space and Einstein space.	6 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	-	-	-	-	-	-	-	-	-	-
CLO3	-	-	♦	♦	-	-	-	♦	-	♦	-	-
CLO4	♦	-	♦	♦	-	♦	-	-	-	-	-	-
CLO5	♦	♦	♦	-	-	♦	-	-	-	-	-	-

♦: Aligned -: Non-aligned

Learning Materials

Recommended Readings

i.	**Spiegel M. R.,** Vector Analysis and An Introduction to Tensor Analysis, *Schaum's Outlines,* 1959.
ii.	**Kay D. C.,** Tensor Calculus, *Schaum's Outlines,* 1988.
iii.	**Spain B.,** Tensor Calculus, *Oliver and Boyd*, 1956.
iv.	**Lawden D. F.,** An introduction to Tensor Calculus and Relativity, *Dover Publications,* 2002.
v.	**Binchey F. A.,** Vectors and Tensors for Engineers and Scientists, John Wiley and Sons Ltd., 1976.
vi.	**Lawden D. F.,** An Introduction to Tensor Calculus and Relativity, *Dover Publications,* 2003.

Supplementary Readings

i.	**Hummel J. A.,** Vector Geometry. *Addison-Wesley Pub Co*, 1965.
ii.	**Eisenhart L. P.,** Riemannian Geometry, *Princeton University Press,* 1997.

Teaching-Learning andAssessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Lonear Programming	**ISCED Code**	0541-414
		Course Code	MTH 414
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Linear Algebra and Probability	**Total Marks**	100

Course Description

Lonear Programming is a core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching **in 14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for learning Linear programming related courses. However, it requires successfully completion of **Linear Algebra and Probability**.

Rationale

Lonear Programming is a method to achieve the best outcome (such as maximum profit or lowest cost) in a mathematical model whose requirements are represented by linear relationships. Linear programming is a special case of mathematical programming (mathematical optimization). More formally, linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. Its feasible region is a convex polytope, which is a set defined as the intersection of finitely many half spaces, each of which is defined by a linear inequality. Its objective function is a real-valued affine (linear) function defined on this polyhedron. A linear programming algorithm finds a point in the polyhedron where this function has the smallest (or largest) value if such a point exists.

Course Objectives

The objective of a **Optimization Methods**problem will be to maximize or to minimize some numerical value. This value may be the expected net present value of a project or a forest property; or it may be the cost of a project; it could also be the amount of wood produced, the expected number of visitor-days at a park, the number of endangered species that will be saved, or the amount of a particular type of habitat to be maintained. Linear programming is an extremely general technique, and its applications are limited mainly by our imaginations and our ingenuity.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic properties and related theorems.
CLO2	Develop knowledge about LP, standard form, canonical form, slack variables, surplus variables, basic solutions, non-basic solutions, feasible solutions, optimal solutions etc.
CLO3	Illustrate the ways to formulate a real life problem into a mathematical problem.
CLO4	Solve two-dimensional problems by using graphical method.
CLO5	Demonstrate the different types of solution procedures (regular simplex method, 2-phase simplex method, Big-M simplex method and Dual simplex method) and interpret the results from different points of view and Create the real life applications.

Course Contents

	Course Contents	Hours	CLOs
1.	**Convex Sets and Related Theorem:** Basic concepts, Convex sets, Convex functions and related theorems.	6 Hrs.	CLO1
2.	**An Introduction to Linear Programming:** A simple maximization/minimization problem, Formulation, Graphical solution	9 Hrs.	CLO1, CLO2 CLO3, CLO4

	procedure, Extreme points and the optimal solution, General linear programming notation and related theorems of feasibility and optimality.		
3.	**Linear Programming Simplex Method:** An algebraic concept of simplex method, Tableau form, Forming the initial simplex tableau, Improving the solution, Solving minimization problem, Special cases: Big-M simplex method and two phase simplex method.	12 Hrs.	CLO1, CLO5
4.	**Duality and Sensitivity Analysis:** Duality, Economic interpretation of dual variables, Using the dual to identify the primal solution, Duality of linear programming and related theorems, Sensitivity analysis and interpretation of solutions with the simplex tableau.	12 Hrs.	CLO1, CLO5
5.	**Applications of Linear Programming**: Marketing applications, Financial applications and operation management applications etc.	3 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	-	-	♦	-	-	-	-
CLO3	♦	-	-	-	♦	♦	-	♦	♦	♦	-	-
CLO4	♦	-	-	-	♦	♦	-	-	-	♦	-	-
CLO5	♦	-	♦	-	♦	♦	-	♦	-	♦	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Hiller F. S., and Lieberman G. T.,**Linear Programming, *Mac-Graw Hill*, 1990.
ii.	**Kambu N. S.,**Mathematical Programming Techniques, *Affiliated East-West Press Pvt. Ltd.,* 1991.
iii.	**Taha H. A.,**Operations Research, *Pearson*, 1971.
iv.	**Sharma J. K.,** Operations Research, *Macmillan India Limited*, 2006.
v.	**Kapoor V. K.,** Operations Research, *Sultan Chand*, 2011.
vi.	**Gupta P. K., and Hira D. S.,** Problems in Operations Research, *S. Chand* 1991.

Supplementary Readings

i.	**Rabindran A., Phillips D. T., and Solberg J. J.,**Operations Research, *John Wiley and Sons*, 1987.
ii.	**Gillet B. E.,** Introduction to Operations Research, *McGraw Hill*, 1976.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Research Methodology	**ISCED Code**	0541-416
		Course Code	MTH 415
Course Type	GED	**Course Status**	Theory
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Computer Fundamentals	**Total Marks**	50

Course Description

Research Methodology is a general education course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credits** and **28 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for mathematics study and research which will provide strong insights for professional writing, compiling and formatting documents, and writing scientific papers, reports and dissertations. However, it requires successful completion of the **Computer Fundamentals** course.

Rationale

A Research methodology and scientific writing course is essential to any undergraduate program, especially for those in Science, Technology, Engineering, and Mathematics (STEM) fields. The course is designed to help students develop the necessary skills to write clear, concise, and well-structured scientific reports and papers. Moreover, students can develop skills to communicate their research effectively, develop critical thinking skills, understand ethical considerations, and succeed academically.

Course Objectives

This course is designed to provide students with the skills and knowledge necessary to write clear, concise, and well-structured scientific reports and papers. The course will cover the basic principles of scientific writing, including scientific communication, research methodology, writing styles, and publication ethics.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Identify the basic principles of scientific writing, including scientific communication, research methodology, writing styles, and publication ethics.
CLO2	Distinguish different types of research, their audiences and how research material might be effectively presented.
CLO3	Write clear, concise, and well-structured scientific reports and papers and Develop critical thinking skills in evaluating scientific literature and writing.
CLO4	Demonstrate effective communication skills in scientific writing, including the use of appropriate language, grammar, and style and Understand the ethical issues surrounding scientific writing, including plagiarism and authorship.
CLO5	Effectively use features of Microsoft Word, PowerPoint, and Excel to create professional looking tables, graphs and figures. Effectively usages of LaTeX manual to write a report/article/proposal and dissertation.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction to Scientific Writing:** Definition of Research, Importance and types of scientific communication, Searching the scientific literature, Using online search engines, Referred Journals, The scientific method and research methodology.	3 Hrs.	CLO1, CLO2
2.	**Writing Style:** Establishing your constraints, Organizing your writing, Preparing outlines, Standard formats for scientific papers, research projects and theses and Style guides.	3 Hrs.	CLO1, CLO2, CLO3, CLO4

3.	**Writing Formal and Informal Reports:** Reports made by filling in blank form, Reports in the form of letters, Reports in the form of memoranda, Progress and status reports, The periodic reports, The laboratory reports, Writing informal reports, Formal and semiformal reports, Description of formal and semiformal reports, Letter of transmittal, Table of contents, Styles in a formal report, The efficiency of formal reports and Specimen of formal report.	3 Hrs.	CLO1, CLO2, CLO3, CLO4
4.	**Procedure in Writing Reports:** Analyzing the job, Making a tentative plan or outline, Gathering information, Report writing on the job, Report writing in a course, Writing the first draft, Revision, Caring for final details.	3 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5
5.	**Computer Software:** Microsoft word, Power point,Latex,andBibtex.	5 Hrs.	CLO3, CLO4
6.	**Evaluating Scientific Literature:** Understanding scientific papers, Evaluating research findings, Developing critical thinking skills, Identifying biases and limitations.	2 Hrs.	CLO2, CLO3 CLO4
7.	**Writing a Scientific Paper/ Project/ Dissertation:** Developing a research question, Conducting literature review, Designing and conducting research, Data analysis and interpretation, Writing and editing a scientific report or paper, Results, Discussions and Abstracts.	4 Hrs.	CLO1, CLO2, CLO3 CLO4, CLO5
8.	**Referencing and Citations:** In-text citation, Formatting, BibliographyandEndnote library.	2 Hrs.	CLO4, CLO5
9.	**Oral presentation of the Reports/ Article/ Proposal/Dissertation:** Preparation, Language, Delivery, Speaking to a larger audience, Articulations, and Attitude.	1 Hrs.	CLO4, CLO5
10.	**Publication Ethics:** Plagiarism and academic integrity, Authorship and publication ethics, The peer review process, and Open access publishing.	2 Hrs.	CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	♦	-	-	♦	♦	♦	♦
CLO2	♦	-	♦	-	-	♦	-	-	-	♦	♦	♦
CLO3	♦	-	♦	♦	-	♦	-	♦	-	♦	♦	♦
CLO4	♦	♦	-	-	-	♦	-	♦	-	♦	♦	♦
CLO5	♦	♦	♦	♦	-	♦	-	-	-	♦	♦	♦

Learning Materials

Recommended Readings

i.	**Sherman A. T., and Johnson S.,** Modern technical writing, *Prentice Hall Inc., New jersey, US,* 1975.
ii.	**Alley M.**,The Craft of Scientific Writing,*Springer*, 1996.
iii.	**Leburn J. L.,** Scientific Writing: A Readers and Writer's Guide, *World Scientific*, 2007.
iv.	**Cargil M., and O'Connor P.,** Writing Scientific Research Articles, *Willey-Blackwell*, 2009.
v.	**Hedge M. N.,** A Course book on Scientific and Professional Writings,*Delmar-Cengage Learning,*2010.

Supplementary Readings

i.	**Robert A. D., and Gastel B.,** How to Write and Publish a Scientific Paper, *Greenwood*, 2016.
ii.	**Alley M.,** The Craft of Scientific Presentations: Critical steps to succeed and critical errors to avoid, *Springer,* 2013.
iii.	**Blackwell J., and Martin J.,** A Scientific Approach to Scientific Writing, *Springer,* 2011.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Math Lab III: Numerical Analysis with MATLAB	**ISCED Code**	0541-416
		Course Code	MTH 416
Course Type	Core	**Course Status**	Lab
Course Hour	2.0 Hr./Week	**Credit Value**	2.0
Prerequisite	Linear Algebra, Calculus, ODE, Numerical analysis	**Total Marks**	100

Course Description

Math Lab III: Numerical Analysis with MATLAB is a core course for the undergraduate students of the B. Sc. (Honors) program, which carries **2.0 credits** and **28 hours** of effective teaching in 14 weeks. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is a mathematics computing course for learning a programming language. However, it requires successful completion of Linear **Algebra, ODEs, Mathematical Modeling in Biology and Numerical Analysis.**

Rationale

Math Lab III: Numerical Analysis with MATLAB focuses on applying computational software: MATLAB/Python, a high-performance technical computing language where problems and solutions are expressed in familiar mathematical notation. The course allows the students to develop skills in programming languages and their proper uses.

Course Objectives

The main objectives of **Math Lab III: Numerical Analysis with MATLAB** is to build and strengthen students' conceptual knowledge of functions, linear functions, equations, inequalities, exponential functions, systems of linear equations and inequalities, calculus of several variables, differential equations, numerical analysis and mathematical modeling. The course will further offer the knowledge of demonstrating, explaining and reinforcing abstract mathematical ideas using concrete objects, models, charts, graphs, pictures, etc.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Describe computer methods for solving a wide range of engineering problems.
CLO2	Use graphical representation of different Mathematical problems.
CLO3	Exploit computer skills to enhance learning and performance in different mathematical courses.
CLO4	Write different codes for solving different types of scientific programming problems described in detail in the syllabus.
CLO5	Apply various simulations in to solve practical problems in diverse fields and consolidate teamwork skills such as dividing tasks, being responsive, and taking responsibility for the work of the team.

Course Contents

	Course Contents	Hours	CLOs
1.	**Discrete Population models for single species:** Simple model, Discrete logistic models, Discrete delay models. Continuous models for interacting populations, Predator-prey models, Lotka-Volterra systems, Complexity and stability, Periodic behavior, Epidemic models and dynamics of infectious diseases, Simple epidemic models and practical applications.	14 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5

2.	**Numerical Analysis**: Numerical solution of Algebraic equation: Bisection method, False position, fixed point iteration method, Newton-Raphson method and corresponding programming. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Weddle's rule, Expression for corresponding error terms and corresponding programming. Numerical solution of ordinary differential equation: Euler's method, Modified Euler's method, SOR method, Adams-Bashforth methods, Runge-Kutta methods, Shooting method.	14 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	-	-	-	♦	-	-	-	♦	♦	-	_
CLO4	♦	♦	-	-	♦	♦	-	♦	-	♦	♦	-
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

i.	**Hunt B. R., Lipsman R. L. and Rosenberg J. M.,** Essential MATLAB for Engineers and Scientists, *Newnes*, 2007.
ii.	**Hunt B. R., Lipsman R. L. and Rosenberg J. M.,** Essential MATLAB for Engineers and Scientists, *Newnes*, 2007.
iii.	**Lopez C. P.,** MATLAB Programming for Numerical Analysis, 1st Edition, *Apress*, 2014.
iv.	**Otto S.R., and Denier J.P.,** An Introduction to Programming and Numerical Methods in MATLAB, *Springer*, 2005.
v.	**Kharab A.,** An Introduction to Numerical Methods: A MATLAB Approach, 4th Edition, *CRC Press,* 2019
vi.	**Ansari, K. A., and BonniDichonei P. E.,** An Introduction to Numerical Methods Using MATLAB, *SDC Publications,* 2019.

Supplementary Readings

i.	**Woodford C. and Phillips C.,** Numerical Methods with Worked Examples: MATLAB Edition, *Springer,* 2012.
ii.	**Chapman S. J.,** MATLAB Programming for Engineers, *6th Edition, Cengage Learning,* 2019.
iii.	**Chapra S.,** Applied Numerical Methods with MATLAB for Engineers and Scientists, *5th Edition, McGraw Hill,* 2022.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Fourth Year Second Semester

Course Title	Functional Analysis	**ISCED Code**	0541-421
		Course Code	MTH 421
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Real Analysis, Linear Algebra and Topology	**Total Marks**	100

Course Description

Functional Analysis is a major, compulsory and core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an essential course for learning the theory of functional analysis. However, it requires successful completion of **Calculus, Complex Analysis, Geometry, Linear Algebra, Real Analysis, and Topology** courses.

Rationale

Functional Analysis owes its origins to the discovery of certain striking analogies between apparently distinct disciplines of mathematics such as analysis, algebra, and geometry. It was found that many concepts of this triad analysis, algebra and geometry-could be incorporated into a single, but considerably more abstract new discipline, which came to be called **Functional Analysis**. Mainly it is a branch of mathematical analysis, the core of which is formed by the study of vector spaces endowed with some limit-related structure (e.g., Inner product, Norm, topology, etc.) and the linear functions defined on these spaces and respecting these structures in a suitable sense. It has numerous applications inordinary and partial differential equations, harmonic analysis, representation theory, geometry, topology, calculus of variations, optimization, quantum physics, statistics, financial mathematics and many other areas.

Course Objectives

Classically, Functional Analysis studies infinite dimensional vector spaces of functions and linear operators between them. This class deals with relevant function spaces (normed vector spaces, Banach and Hilbert spaces), bounded linear operators on normed vector spaces, fundamental principles of functional analysis (i.e., Han-Banach theorem, Uniform boundedness principle, Open mapping theorem, and Closed graph theorem) and their applications. The course aims to help students who pursue advanced studies in mathematics and related fields to lay a solid foundation in functional analysis. Moreover, students can use this course to perform the mathematical analysis of **Differential Equations** and many other areas.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts and fundamental principles of functional analysis.
CLO2	Develop a strong foundation in functional analysis, focusing on spaces (Metric Spaces, Banach spaces, Normed spaces, Inner product spaces, Hilbert spaces), Operators, Linear functional, and so on.
CLO3	Familiarity with the central theorems, independently prove, Analyze and thoroughly explain the fundamental results of those theorems in the theory of accuracy and formalism and Distinguish the difference between analysis in finite and infinite dimensional analysis.
CLO4	Construct examples and counterexamples illustrating the mathematical concepts presented in the course and Demonstrate capacity for mathematical reasoning through analyzing, proving, and explaining concepts from functional analysis
CLO5	Illustrate the concepts of functional analysis in the wide range for mathematical analysis and problem-solving in Calculus of variations, Ordinary and Partial Differential Equations and Representation theory and Apply acquired pieces of knowledge for solving problems in Quantum mechanics, Statistics, Applied data analysis, and financial mathematics.

Course Contents

	Course Contents	Hours	CLOs
1.	**Metric Space**s: Definition and further examples of metric space, Pseudo and discrete metric space, Convergence, Cauchy sequence, Completeness proofs and Completion of metric space with other related theorems.	8 Hrs.	CLO1, CLO2, CLO3, CLO5
2.	**Normed Spaces and Banach Spaces:** Vector Space, Normed space, Banach space, Compactness, Bounded and continuous linear operators, Linear operators and functional in finite dimensional space, Normed space operator and Dual space.	9 Hrs.	CLO1,CLO2, CLO3 CLO4,
3.	**Lebesgue Integrals:** Lebesgue intangibility, Lebesgue integral functions from a linear space**.**	4 Hrs.	CLO1, CLO3
4.	**Inner Product Spaces:** Inner product space, and its further properties, Orthogonal complements, Direct sum sets sequences, Orthogonality, Self-adjoint, Unitary operators and Bessel's inequality.	8 Hrs.	CLO2, CLO3 CLO4, CLO5
5.	**Theorems on Norm and Banach Spaces**: Axioms of choice, Zorn's lemma, Hahn-Banach theorem, Applications of bounded Linear functional, Open mapping theorem, Closed linear operator and Closed graph theorems.	7 Hrs.	CL03, CLO5
6.	**Hilbert Spaces:** Hilbert space and further properties**,** Projection theorems, Reisz representation theorems and Adjoint operators.	6 Hrs.	CLO2, CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦		♦	-	-	-	-	♦	♦	♦	-	-
CLO3	-	-	♦	-	-	♦	-	♦	♦	♦	-	-
CLO4	-	-	♦	-	-	-	-	-	-	-	-	-
CLO5	♦	-	♦	-	-	♦	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Kreyszig E.,** Introduction to Functional analysis with Applications,*Wiely*,1978.
iii.	**Schechter M.,** Principles of Functional Analysis, *AMS*, 2002.
ix.	**Oden T. J.and Demkowicz L.,** Applied Functional Analysis, *Chapman and Hall*, 2018.

Supplementary Readings

i.	**Brezis H.,** Functional Analysis, Sobolev Spaces and Partial Differential Equations, *Universitext, Springer*, 2011.
iii.	**Rudin W.,** Functional Analysis,*MaGraw Hill*, 1991.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Dynamics	**ISCED Code**	0541-422
		Course Code	MTH 422
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Dynamics is a major course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. Dynamics is an enormously vast field and an essential tool for studying problems in many areas of mathematics, particularly in Modern physics, motion in a rigid bodies as well as the celestial mechanics.

Rationale

This course is designed to provide extensive knowledge about the dynamics and know the solution procedure of different mathematical problems.

Course Objectives

By studying this course, students can learn the fundamentals of classical and modern physics and the laws of mechanics. Learners can apply mathematical physics to handle diverse problems that occur in real-life situations. Students can get the basic ideas to develop the techniques needed in quantum mechanics and classical relativity.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Achieve the knowledge on the body of motion on earth or space and Improve the analytical and computational ability in the dynamical problems.
CLO2	Apply the theorems and problems on motion in a line and Illustrate the theorems and problems on motion in a plane.
CLO3	Learn the theorems and problems on motion of a particle under a central force and Understand the theorems and problems on motion in two dimensions.
CLO4	Solve the problems by using theorems and problems on Motion of a particle in space and Understands the theorems and problems on motion of rigid bodies, moment of inertia, D' Alembert's principle.
CLO5	Know the theorems and problems on motion about fixed axes.

Course Contents

	Course Contents	Hours	CLOs
1.	Motion in a line.	04 Hrs.	CLO1, CLO2, CLO3
2.	Motion in a plane.	04 Hrs.	CLO1, CLO2, CLO4
3.	Motion of a particle under a central force.	06 Hrs.	CLO1, CLO2, CLO5
4.	Motion in two dimensions.	06 Hrs.	CLO1, CLO2
5	Motion of a particle in space.	06 Hrs.	CLO2
7.	Motion of rigid bodies, Moment of inertia, D' Alembert's principle	08 Hrs.	CLO1, CLO2, CLO5
8.	Motion about fixed axes.	08 Hrs.	CLO1, CLO2

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	_	-	-
CLO2	♦	-	♦	♦	-	-	-	_	_	_	-	-
CLO3	-	♦	♦	-	♦	♦	♦	-	-	-	_	_
CLO4	-	♦	♦	♦	-	♦	-	-	-	_	_	_
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	_	_	_

♦: Aligned -: Non-aligned

Learning Materials

Recommended Readings

i.	**Loney S. L,** An Elementary Treatise on Statics, *Cambridge University press*, 2016.
ii.	**Ramsey A. S.**, Statics, *CBS Publishers,* 2004.

Supplementary Readings

i.	**Yousuf M. A.,** Mechanics (Statics and Dynamics).

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework and Assignment (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing, Students Activity and Group Discussion	Homework (Formative) and Final exam (Summative)

Course Title	Hydrodynamics	**ISCED Code**	0541-423
		Course Code	MTH 423
Course Type	Core	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	3.0
Prerequisite	Fundamentals of Physics, Complex Analysis, Vector Calculus and Differential Equations	**Total Marks**	100

Course Description

Hydrodynamics is a core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in 14 weeks. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory of functional analysis. However, it requires successful completion of **Physics, Complex Analysis, Vector Calculus and Differential equations** courses**.**

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 conservation principles 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 geotropic flows, and the influence of wind stress.

Course Objectives

The objective of the course is to provide the students with a basic and applied knowledge of fluid mechanics as required in the design of efficient ocean vehicles, platforms and structures.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Solve the wide range of problems in fluid mechanics that are encountered as a working ocean engineer.
CLO2	Know the basic principles of fluid mechanics to provide a basis for the solution of advanced problems as encountered in graduate school or as a working ocean engineer.
CLO3	Formulate creative design solutions in the area of fluid mechanics.
CLO4	Understand the circulation theorems and find the relation between circulation and vorticity.
CLO5	Apply Kelvin's circulation theorem to the study of incompressible, inviscid fluid flows and know numerical algorithms and an ability to utilize software packages for the solution of complex flowproblems.
CLO6	

Course Contents

	Course Contents	Hours	CLOs
1.	Velocity and acceleration of fluid particles, Relation between local and individual rates, Steady and Unsteady flows, Equations of continuity, Equation of continuity in spherical and cylindrical polar coordinates, Boundary surface, Uniform and non-uniform flows, Stream lines, Path lines, Vorticity vector, Rotational and irrotational flows and Angular velocity vector.	10 Hrs.	CLO1, CLO2

2.	Euler's equation of motion, Conservative field of force, Motion under conservative body force and Lagrange's hydrodynamical equations of motion.	8 Hrs.	CLO1, CLO2
3.	Bernoulli's equation and its application.	4 Hrs.	CLO3, CLO4
4.	Motion in two dimensions, Stream function, Physical meaning of stream function, Velocity in polar coordinates, Relation between stream function and velocity potential, Sources, sinks and doublets, Complex potential and complex velocity, stagnation points, Complex potential due to a source and a doublet, Image system, Circle theorem and its application, Blasius theorem and Cauchy residue theorem.	8 Hrs.	CLO3, CLO4
5.	Flow and Circulation, Stokes's Theorem, Kelvin's circulation theorem, Permanence of irrotational motion equation of energy and Kelvin's minimum energy theorem.	6 Hrs.	CLO3, CLO4 CLO5
6.	Motion of a circular cylinder and Liquid streaming past a fixed circular cylinder.	6 Hrs.	CLO3, CLO4 CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO2	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO3	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO4	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-
CLO5	♦	♦	-	♦	♦	♦	♦	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Milne-Thompson L. M.,**Theoretical Hydrodynamics, *Dover Publications,* 2011.
iii.	**Chorlton F.,** A Text book of Fluid Dynamics, *CBS,* 2004.

Supplementary Readings

i.	**Raisinghania M. D.**, Fluid Dynamics, *S. Chand & Company Ltd.,* 2013.
ii.	**White F. M.**, Fluid Mechanics, *McGraw Hill,* 2015.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Mathematical Modeling in Biology	**ISCED Code**	0541-424
		Course Code	MTH 424
Course Type	Core	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Ordinary and Partial Differential Equations.	**Total Marks**	100

Course Description

Mathematical Modeling in Biology is a major/compulsory/core course for undergraduate B. Sc. (Honors) program undergraduate students. It carries **3.0 credits,** and the total conducted class duration is **42 hours** in **14 weeks**. The course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive exams. This is an applied mathematics course. To understand the contents of this course, the student must have knowledge on **Ordinary Ordinary Differential Equations and Partial Differential Equations** courses.

Rationale

Mathematical modeling plays an important role in studying and formulating mathematical framework of various real-world problems in Biology, Ecology, Genetics, Biotechnology, etc. In the field of biology, mathematical modeling has a wide range of applications, from simple descriptive systems to highly complex systems. These models can be used to study population dynamics, ecological interactions, biochemical reactions, cell signaling pathways, immunological responses, epidemiology, and genetic inheritance patterns, among others. Based on the importance of modeling in real-life applications, this course is designed for 4th-year students to enhance their understanding of modeling, analysis and interpreting the results of various real-world problems.

Course Objectives

This course aims to improve students' basic knowledge about mathematical modeling so that they can write mathematical models of fundamental biological processes, understand their consequences through simulation and mathematical analysis, and apply these skills to a problem from their own research.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts of simple ODE models to discuss in population dynamics.
CLO2	Learn innovative ideas and qualitative problem-solving skills in biological problems and understand the continuous and discrete population models for single species and two species.
CLO3	Develop techniques of Epidemic models and dynamics of infectious diseases and plan for sensitivity analysis.
CLO4	Compare evidence to model prediction. Turn words into equations and analyze stability and explain model results in plain language. Use models to make decisions. Recognize caveats and cautions.
CLO5	Prepare for advance study in mathematical biology and biomedical problems.

Course Contents

	Course Contents	Hours	CLOs
1.	**Continuous Population Models for Single Species:** Continuous growth models, Delay models, Periodic fluctuations and Harvesting models.	8 Hrs.	CLO1, CLO2, CLO3
2.	**Discrete Population models for Single Species:** Simple model, Discrete logistic models, Discrete delay models.	9 Hrs.	CLO1, CLO2, CLO3, CLO3

3.	**Continuous Models for Interacting Populations:** Predator-prey models, Lotka-Volterra systems, Complexity and stability, Periodic behavior, Competition models and Mutualism.	10 Hrs.	CLO1, CLO2, CLO3, CLO5,
4.	**Discrete Growth models for Interacting Populations:** Predator-Prey models and Competition models.	8 Hrs.	CLO1, CLO2, CLO3 , CLO5
5.	**Epidemic Models and Dynamics of Infectious Diseases:** Simple epidemic models and practical applications.	7 Hrs.	CL01, CLO2, CLO4

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	♦	-	-	-	-	-
CLO2	-	♦	-	-	-	-	-	♦	-	-	-	-
CLO3	♦	-	-	♦	-	-	-	-	-	♦	-	-
CLO4	♦	-	-	♦	♦	-	-	-	♦	♦	-	-
CLO5	-	-	-	-	♦	-	♦	♦	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Murray J. D.,** Mathematical Biology I: An Introduction, *Springer, 2001.*
ii.	**Murray J. D.,** Mathematical Biology II: Spatial Models and Biomedical Applications, *Springer,* 2001.
iii.	**Burghes D. N., and Borrie M. S.,** Modeling with Differential Equation,*Prentice Hall Europe,* 1981.
iv.	**Britton F. N.,** Essential Mathematical Biology, *Springer,* 2003.
v.	**Frauenthal J. C.,** Introduction to population modeling, *Birkhäuser,* 2012.

Supplementary Readings

i.	**Zill D. G., and Wright W. S.,** Mathematical Modeling ordinary Differential Equations, *Cengage Learning*, 2012.
ii.	**Ross S. L.,** Differential Equation, *John Wiley and Sons. Inc.,* 1985.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Student Activity	Quiz/ Homework (Formative)
CLO2	Lecturing, Discussion and Student Activity	Midterm (Summative)
CLO3	Lecturing, Discussion and Student Activity	Assignment (Formative) and Midterm (Summative)
CLO4	Lecturing and Visual Presentation	Midterm and Final Exam (Summative)
CLO5	Lecturing and Discussion	Final Exam (Summative)

Course Title	Comprehensive Viva	**ISCED Code**	0541-499
		Course Code	MTH 499
Course Type	Core	**Course Status**	Oral/Presentation
Course Hour	---	**Credit Value**	2.0
Prerequisite	Recommended Books and Lecture Materials	**Total Marks**	100

Course Description

Comprehensive Viva is a major/compulsory/core course for undergraduate students of B. Sc. Students pursue a **2.0 credit** (Honors) program, requiring effective teaching in the first and second semesters. Course grades will be assessed through participation, class presentations, quizzes, and comprehensive examinations. However, it requires successful completion of all courses in the first and second semesters.

Rationale

Yearly Comprehensive viva gives students the opportunity to demonstrate their understanding of the subject and answer questions.

Course Objectives

This is a platform to practice and show their smartness and confidence, as well as to address immediate issues in the society.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Realize themselves through oral assessment that helps students develop valuable communication skills.
CLO2	Enable interactive dialogue between candidate and assessor, allowing the examinee to demonstrate strengths and letting examiners discriminate between superficial and real knowledge via in-depth questioning.
CLO3	Have the ability to tailor the questions asked to the needs of each individual.
CLO4	Assess on the spot. Recent years have seen this traditional form of assessment used mostly to defend different subjects.
CLO5	In order to discriminate among the top achieving students, higher order cognitive skills can be tested by in-depth questioning.

Course Contents

	Course Contents	Duration	CLOs
1.	Students respond orally to questions during the comprehensive viva examination. These tests frequently draw from both the first and second semesters' worth of coursework. A vital component of academic programs, viva exams are frequently administered at the end of each academic year.	First and Second Semester	CLO1, CLO2, CLO3, CLO4, CLO5
2.	These Viva examinations formed part of the theory component of the final summative examination in the second semester of the first year. Since the Viva Voce is conducted for all students irrespective of their passing status in theory, the exercise is time consuming. To determine the impact of viva voce examinations on summative examination performance, this study has been conducted.		
3.	The main focus of the assessment is on the written/ thesis/dissertation (and other outputs, for a Practice as Research students) in communicative English, basic computer knowledge, physics, statistics, algebra, geometry in two dimensions and differential calculus. Since		

	mathematics is a fundamental subject, job-seeking students should investigate it at many organizations in the labor market. Viva voce is necessary to make mathematics appealing to the business and research fields.		

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	-	♦	-	♦	-	-	-	-
CLO2	♦	♦	♦	♦	-	-	-	-	-	-	-	-
CLO3	-	♦	-	♦	-	♦	♦	♦	♦	-	♦	-
CLO4	-	-	♦	-	♦	♦	♦	-	♦	♦	♦	♦
CLO5	-	-	♦	-	-	-	-	-	♦	♦	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	All the recommended books of Fourth Year 1st and 2nd semester.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Short questions, Quiz or Presentation
CLO2	Lecturing and Discussion	Short questions, Quiz or Presentation
CLO3	Lecturing and Group Discussion	Short questions, Quiz or Presentation
CLO4	Lecturing and Group Discussion	Short questions, Quiz or Presentation
CLO5	Lecturing and Students Activity	Short questions, Quiz or Presentation

Elective Courses

Course Title	Measure Theory	**ISCED Code**	0541-425
		Course Code	MTH 425
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Linear Algebra, Real Analysis, and Topology.	**Total Marks**	100

Course Description

Measure Theory is an optional core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is a basic course for understanding the Introduction to Measure Theory. However, it requires successful completion of **Calculus, Complex Analysis, Geometry, Linear Algebra, Real Analysis, and Topology**.

Rationale

This course is an introduction to measure, integration theory, and their applications to the approximation of real-valued functions. The course focuses on the generalization of the idea of length, area, and volume of a subset of Euclidean space to the so-called measure of a set. The idea of measure broadens the class of integrable functions compared to the Riemann integrable functions. Then we study convergence for sequences of integrable functions. The course is designed to provide the elementary introduction needed for an advanced abstract course on Measure and Integration.

Course Objectives

The main objective of the course is the generalization of the idea of length, area, and volume of a subset of Euclidean space to measure a set, exploiting the idea of measure to enrich the class of integrable functions from the class of Riemann integrable functions, and to discuss the properties of measurable functions and integration on $\mathbb{R}^n$.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand the basic concepts and fundamental principles of Measure and Lebesgue measure.
CLO2	Achieve a strong foundation in Measurable functions and their properties, convergence sequence of measurable functions and its consequences.
CLO3	Familiarity with the central theorems, independently prove, and thoroughly explain the fundamental results of those theorems in the theory of accuracy and formalism.
CLO4	Construct examples and counterexamples illustrating the mathematical concepts presented in the course and Apply acquired pieces of knowledge for solving problems in statistics, applied data analysis, and financial mathematics. A student will get prepared for an advanced abstract course on measure and integration.
CLO5	Idea of measure helps to define integration of wider class of functions and its properties and Demonstrate capacity for mathematical reasoning through analyzing, proving, and explaining concepts from Measure theory. Describe the shortcomings of Riemann integral and benefits of Lebesgue integral.

Course Contents

	Course Contents	Hours	CLOs
1.	**Outer Measure:** Set functions, Extended real number line, Outer measure on $\mathbb{R}$, Good properties of outer measure, Open cover, Finite sub cover, and completion of measure.	8 Hrs.	CLO1, CLO2, CLO3, CLO5
2.	**Measurable Spaces and Functions:** Sigma algebra, Measurable spaces, Measurable set, Borel subsets, Measurable functions, Characteristic functions and Borel measurable functions.	8 Hrs.	CLO1,CLO2, CLO3 CLO4

3.	**Measure:** Measure and its properties, Measure space, Null set, Completeness of measure and Caratheodory extension theorem.	6 Hrs.	CL03, CLO4
4.	**Lebesgue Measure:** Lebesgue measurable set, Lebesgue measure, Lebesgue measurable function, Cantor set, and Cantor function.	4 Hrs.	CLO1, CLO3
5.	**Integration:** S-partitions, Integral of a nonnegative number, Characteristic function, simple function, Monotone convergence theorem (MCT), Lebesgue Dominated convergence theorem (LDCT) and Integration of real valued functions and properties.	10 Hrs.	CLO2, CLO3 CLO4
6.	**Differentiation:** Hardy-Littlewood maximal function, Vitali covering lemma, Lebesgue differentiation theorem, Fundamental theorem of calculus, Density, Lebesgue density theorem**.**	6 Hrs.	CLO2, CLO3, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	-	-	-	♦	♦	♦	-	-
CLO3	-	-	♦	-	-	♦	-	♦	♦	♦	-	-
CLO4	♦	-	♦	-	-	♦	-	-	-	-	-	-
CLO5	♦	♦	♦	♦	♦	♦	-	♦	♦	♦	-	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Cannarsa P., and D'Aprile T.,** Introduction to Measure Theory and Functional Analysis, *Springer,* 2015.
ii.	**Halmos P. R.**, Measure Theory, S*pringer*,1950.
iii.	**Bartle R. G.,** The elements of integration and Lebesgue measure, Wiley Classics Library, 1995.
iv.	**Debnath L., and Mikusinski P.,** Introduction to Hilbert Spaces with Applications, *Academic press*, 2005.

Supplementary Readings

i.	**Folland G. B.,** Real Analysis, Modern Techniques and Their Application, second edition, *A Wiley-Interscience Series of Text,* 2007.
ii.	**Simmons G. F**., Introduction to topology and modern analysis, *McGraw Hill,* 1963.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Differential Geometry	**ISCED Code**	0541-426
		Course Code	MTH 426
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Differential and Integral Calculus	**Total Marks**	100

Course Description

Differential Geometry is an optional core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. The main purpose for this course is to introduce the concepts of curves and surfaces. However, it requires successful completion of **Integral and Differential Calculus, Multivariable Calculus and Linear Algebra** courses.

Rationale

The course introduces the fundamentals of differential geometry primarily by focusing on the theory of curves and surfaces in three spaces. The theory of curves studies the global properties of curves, such as the four vertex theorem. The theory of surfaces introduces the fundamental quadratic forms of a surface intrinsic and extrinsic geometry of surfaces. It uses the techniques of differential calculus, integral calculus, and multilinear algebra.

Course Objectives

Differential Geometry is the study of geometric properties of curves, surfaces, and their higher dimensional analogues using the methods of calculus. Differential geometry has proven indispensable to an understanding of the physical world, in Einstein's general theory of relativity, in the theory of gravitation, in gauge theory, and now in string theory. Differential geometry is also useful in topology, several complex variables, algebraic geometry, complex manifolds, and dynamical systems, among other fields.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Recognize the fundamental concepts and notations of differential geometry.
CLO2	Demonstrate the fundamental techniques of curves in space and surfaces.
CLO3	Develop the arguments in the geometric description of curves and surfaces.
CLO4	Demonstrate the properties of curves in space and surfaces.
CLO5	Analyze the equivalence of two curves by applying some theorems and Acquire geometrical problem-solving and analysis skills that may be applied to diverse situations in mathematics, physics, and engineering.

Course Contents

	Course Contents	Hours	CLOs
1.	**Curves in Space:** Vector functions of one variable, Space curves, Unit tangent to a space curve, Equation of a tangent line to a curve and osculating plane (or plane of curvature	6 Hrs.	CLO1, CLO2
2.	**Curves in Space:** Vector function of two variables, Tangent and normal plane for surface $f(x, y, z) = 0$, Principal normal, Binormal and fundamental planes, Curvature and torsion, SerretFrenet's formulae and theorems on curvature and torsion.	8 Hrs.	CLO2, CLO3, CLO 4
3.	**Curves in Space:** Helices and its properties, Circular helix, Spherical indicatrix, Curvature and torsion for spherical indicatrices, Involutes and Evolutes of a given curve and Bertrand's curve.	6 Hrs.	CLO3, CLO4, CLO5

4.	**Surface:** Curvilinear coordinates, Parametric curves, Metric (first fundamental form), Geometrical interpretation of metric, Relation between coefficients E.F.G., Properties of metric, Angle between parametric curves, Elements of area and second fundamental form.	8 Hrs.	CLO1, CLO2, CLO3
5.	**Surface:** Derivatives of surface normal (Weingarten equations), Third fundamental form, Principal sections, Direction and curvature, First curvature, Mean curvature, Gaussian curvature, Normal curvature, Lines of curvature and centre of curvature.	8 Hrs.	CLO4, CLO5
6.	**Surface:** Rodrigues's formula, Condition for parametric curves to be line of curvature, Euler's theorem, Elliptic, Hyperbolic and parabolic points and Dupin indicatrix.	6 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO 1	PLO 2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12
CLO1	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO3	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	♦	-	♦	-	-	-	-	-	-	-	-
CLO5	♦	♦	-	♦	-	-	-	-	-	-	-	-
CLO7	-	♦	♦	-	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Kuhnel W.,** Differential Geometry: Curves – Surfaces Manifolds *Student mathematical library, vol. 16. Providence, RI: American Mathematical Society,* 2002.
ii.	**Pressley A.,** Elementary Differential Geometry, *Springer undergraduate mathematics series,* London, *UK: Springer*, 2002.
iii.	**Spivak M.,** A Comprehensive Introduction to Differential Geometry, *Vol. 2. Boston, MA: Publish or Perish,* 1999.
iv.	**Richard S., and Shing-Tung Y.,** Lectures on Differential Geometry*, International Press of Boston,* 2010.

Supplementary Readings

i.	**Struik D. J.,**Lectures on Classical Differential Geometry, *Dover Books,* 1988.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Applied Data Analysis	**ISCED Code**	0541-427
		Course Code	MTH 427
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Fundamentals of Statistics, Data Analysis, Graph Theory, Geometry and Calculus	**Total Marks**	100

Course Description

Applied Data Analysis is the science of analyzing data to convert information into knowledge. This is an applied statistics course focused on the fundamentals of statistical inference and applied data analysis tools. It carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. Course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This is an essential course to understand modern physics. However, it requires successful completion of **Fundamentals of Statistics, Data Analysis, Graph Theory, Geometry and Calculus.**

Rationale

Applied Data Analysis will provide experiences for the student. Emphasis on thinking statistically, evaluating assumptions, and developing practical skills for real-life applications in industry and academia. Topics include t-tests and non-parametric alternatives, multiple comparisons, analysis of variance, linear regression, model refinement, missing data, and causal inference.

Course Objectives

Upon completing this course, students can expect to gain a working knowledge of statistical software R/Python. This will be used for data analysis and simulations designed to strengthen conceptual understanding.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Understand about data and specialized information required for real life data analysis and decision making.
CLO2	Understand the fundamentals data management, interpretation and forecasting based on current and previous knowledge's.
CLO3	Perform data wrangling (fixing missing and incorrect data, data reconciliation, data quality assessments, etc.)
CLO4	Analyze perform data interpretation (statistics, correlation vs. causality, knowledge extraction, critical hiking, team discussions, ad-hoc visualizations, etc.) Identify and describe perform result dissemination (reporting, visualizations, publishing reproducible results, ethical concerns, etc.
CLO5	Explain and implement optimal algorithms for solving real-life applications of data such as graph coloring problems, real problem, and so on. Describe and apply data and provide some basic algorithms for different problems as a modelling tool.

Course Contents

	Course Contents	Hours	CLOs
1.	**Introduction:** Rules for probability, Random variables and their distributions, Moments, Special discrete and continuous distribution, Laws of large numbers and Central limit theorem, Sampling distributions.	8 Hrs.	CLO1, CLO2, CLO3
2.	**Hypotheses and Inferences:** Hypothesis test of population mean, P-values, CI for the difference of two population means, Hypothesis tests involving 2 population means, z-test and two sample t-test.	7 Hrs.	CLO1, CLO2, CLO4
3.	**ANOVA:** Random block design (RBD), Completely randomized design (CRD), Latin hypercube design (LHD), Single factor ANOVA, Multiple comparisons in	9 Hrs.	CLO3, CLO4,

	ANOVA, Two factor ANOVA, T-method, 2p factorial experiments, Aliasing/confounding of a 2pfactorial experiment, Yates algorithm to compute fitted effects, CI for factor effects, Tukey procedures for 2pfactorial experiments.		CLO5,
4.	**Interval Estimation:** Basic properties of confidence Intervals (CI), Large sample CI for population mean, CI for variance and standard deviation, Intervals based on normal population.	6 Hrs.	CLO3, CLO
5.	**Regression and Correlation:** Basics of regression, Least squares, Interpretation, Model specification, Standard error, Coefficients determination, Model comparison, F-test, fitted values, residuals, mean squared error, Outliers; influence, Multivariate regression, Log-transformation, Correlation, Correlation vs causation, Causal relationship, Assessing model adequacy, Regression with transformed variables, Polynomial regression and multiple regression analysis, Coefficient of determination R2, Adjusted R2, Interpret plot of residuals.	9 Hrs.	CLO 3,CLO4, CLO5
6.	**Machine learning:** Core-concepts, Supervised vs unsupervised learning, Introduction to classification, Clustering, k-means, Latent class/profile analysis, Decision trees and Neural networks.	3 Hrs.	CLO2, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦		-	-	-	-	-	-	-	-	-
CLO2	♦	♦	-	♦	-	-	-	♦	-	-	-	-
CLO3	-	♦	-	♦	-	-	-	♦	-	-	-	♦
CLO4	-	-	♦	-	-	♦	-	♦	-	-	-	-
CLO5	-	-	♦	-	-	♦	-	-	-	♦	♦	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Devore D. J.**, Probability and Statistics for Engineering and the Sciences, *Cengage Learning products,* 2010.
ii.	**Douglas C. M., and Runger G. C.**, Applied Statistics and Probability for Engineers, *John Wiley & Sons*, 2010.

Supplementary Readings

i.	**Hastie, Trevor et al**., The elements of Statistical Learning, *Springer*, 2008.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Astronomy	**ISCED Code**	0541-428
		Course Code	MTH 428
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	3.0
Prerequisite	Geometry and Mechanics	**Total Marks**	100

Course Description

Astronomy is a core and optional course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching **in 14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This is an elementary-level course for the theory group and their structures. However, it requires successful completion of **Geometry and Mechanics** courses.

Rationale

Astronomy is a science that seeks to explain everything we observe in the Universe, from the comets and planets in our solar system to distant galaxies to the echoes of the Big Bang. By studying the cosmos beyond our planet, we can understand where we came from, where we are going, and how physics works under conditions which are impossible to recreate on Earth.

Course Objectives

The aim of this course is to apply basic physical principles from a broad range of topics in physics to astronomical situations. This course will helps to formulate scientific problems in mathematical terms and apply analytical and numerical methods towards their solution. Moreover this course generates scope to develop skills in designing observing projects with research telescopes and projects drawing upon data in the literature and archives. Establish competence in focused areas of astrophysical theory and experiment.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Describe the historical basis of our understanding of the solar system.
CLO2	Define the sky motions of the Sun, Moon, planets and 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 and Analyzed the life cycles of stars and explain the difference between white dwarfs, neutron stars, and black holes.

Course Contents

	Course Contents	Hours	CLOs
1.	**Celestial Sphere**: Sphere and spherical triangles, The celestial sphere, Problems connected with diurnal motion.	9 Hrs.	CLO1
2.	**Astronomical Refraction**: Astronomical refraction, Astronomical instruments, Finding the latitude of a place, Conversion of coordinates fixing and the ecliptic and first point of aries.	9 Hrs.	CLO1, CLO2
3.	**Solar system**: Kepler's laws, Equation of time and Unit of time.	9 Hrs.	CLO2, CLO3, CLO4, CLO5
4.	**Parallax:** Geocentric parallax, the moon, Local line and Eclipses.	9 Hrs.	CLO2, CLO3, CLO5
5.	**Modern instruments**: Modern finding of astronomical objects, Working process of the Hubble telescope and its finding.	6 Hrs.	CLO4, CLO6

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	♦	♦	-	-	-	-	-	-	-
CLO2	♦	♦	-	♦	♦	-	-	-	-	-	-	-
CLO3	♦	♦	-	♦	♦	-	-	-	-	-	-	-
CLO4	♦	♦	-	♦	♦	-	-	-	-	-	-	-
CLO5	♦	♦	-	♦	♦	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Hunter T.**, Spherical Trigonometry, *Create Space Independent Publishing Platform,* 2013.
ii.	**Smart W. R.**, Spherical Astronomy, Cambridge *University Press,* 1977.
iii.	**Kar J. M.**, Astronomy, *Gyan Books Pvt. Ltd.*

Supplementary Readings

i.	**Ramnchandran G. V**., A text book of Astronomy, *St. Josephs Industrial School Press,* 1951.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy &Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Assignment, Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Graph Theory	**ISCED Code**	0541-429
		Course Code	MTH 429
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Basic Concept on graph, Co-ordinate Geometry, Vector and Calculus	**Total Marks**	100

Course Description

Graph Theory is a core optional course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks. Undergraduate students can apply graph theory to real-life applications in this advanced course.** Course grades will be assessed through participation, class presentations, quizzes, assignments, two midterms, and comprehensive examinations. This is an essential course to understand modern physics. However, it requires **Fundamentals of Mathematica, Basic Concept on Graph, Calculus, Vectors and Geometry.**

Rationale

Graph Theory will provide experiences for the student that will lead him/her to understand the graph and the nature of a function. It will combine some basic integration, differentiation, and discussion of equations, differential equations with nature.

Course Objectives

Graph theory has seen a surge of interest and activity in applied mathematics and engineering over the past few decades. This mathematics branch was born in 1736 when Euler's paper solved the Konigsberg bridge problem. Many practical problems need to be converted into graph theoretic problems for solutions. This course deals with fundamental and advanced graph theory concepts. Emphasis will be given on understanding the basic theory of graphs, proof techniques, and how to apply them to develop a solution for real-life applications.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Upon completion of this course the students will be able to: state how graph theory represents many problems in terms of geometrical view.
CLO2	Describe the main concept of tree's, spanning tree, fundamental circuits connectivity, reparability, and vulnerability of graphs.
CLO3	Describe and apply some basic algorithms for graphs as a modelling tool.
CLO4	Manipulate graph representation in algebraically.
CLO5	Interpret the use of matrices to represent the graph and explain and implement optimal algorithms for solving real-life applications of graph theory such as graph coloring problems, electrical network analysis, and so on.

Course Contents

	Course Contents	Hours	CLOs
1.	**Graph, Paths and Circuits**: Definition of graph, Types of graphs, Application of graphs, History of graph Theory, Subgraphs, Walks, Paths, Circuits, Euler Graphs, Isomorphism, Multicolored Cubes, Hamiltonian Paths and Circuits.	5 Hrs.	CLO1, CLO3
2.	**Tress and Fundamental Circuits**: Properties of trees, Spanning trees, Fundamental circuits, Finding all spanning trees, Methods of finding Minimum spanning tree.	5 Hrs.	CLO2, CLO3
3.	**Cut Set and Cut Vertices**: Properties of cut set, Fundamental cut set, Connectivity, Reparability, Network flows.	7 Hrs.	CLO2, CLO3

4.	**Planar and Dual Graphs**: Combinatorial Vs. Geometric graphs, Planar graphs, Kuratowski's two graphs.	6 Hrs.	CLO2, CLO3
5.	**Vector Spaces of a Graph**: Sets with one and two Operations, Modular arithmetic and Galois fields, Vector space associated with a graph, Circuit and Cut set subspaces.	5 Hrs.	CLO4, CLO5
6.	**Matrix Representation of Graph**: Incidence matrix, Sub-Matrices of A (G), Circuit and Fundamental circuit, Cut set, Path, Adjacent matrix, Relationships among Af, Bf, and Cf, Application in switching network.	5 Hrs.	CLO4, CLO5,
7.	**Coloring, Covering, Partitioning and Directed Graphs**: Chromatic number, Matching, Coverings, Digrpahs, Euler digraphs, Adjacency of digraph, Shortest path algorithm.	5 Hrs.	CLO1, CLO3 CLO4 ,CLO5
8.	**Application of Graph Theory**: Graph theory in Switching and Coding theory, Electrical network Analysis, Application in operation research.	4 Hrs.	CLO1, CLO3

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	♦	-	-	-	-
CLO2	-	♦	♦	♦	-	-	♦	-	-	-	♦	-
CLO3	♦	-	♦	♦	-	♦	♦	-	♦	-	♦	-
CLO4	-	-	-	♦	-	-	-	♦	-	♦	-	-
CLO5	-	-	-	-	♦	-	-	-	-	♦	-	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Deo N.,** Graph Theory with Applications to Engineering and Computer Science,*Dover Publications,* 2016.
ii.	**West D. B.,** Introduction to Graph Theory, *Prentice Hall,* 2009.
iii.	**Bondy J. A., and Murty U. S. R.,** Graph Theory, *Springer*, *USR,* 2008.

Supplementary Reading

i.	**Diestel R**., Graph theory, *Springer*, 2000.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Discussion and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Quiz/Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Assignment, Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion, Students Activity	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing and Students Activity	Homework (Formative) and Final exam (Summative)

Course Title	Financial Mathematics	**ISCED Code**	0541-430
		Course Code	MTH 430
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	Differential Calculus, Integral Calculus	**Total Marks**	100

Course Description

Financial Mathematics is optional core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations. This course's main purpose is to introduce the time value of money, annuities and cash flows, loans, bonds, general cash flows and portfolios, immunization, derivatives, options, swaps, and hedging and investment strategies. Some concepts from probability related to financial mathematics will also be covered.

Rationale

Financial Mathematics will provide students with an introduction to the mathematical and numerical models used to price financial securities and to make risk estimates. The field of mathematical finance is a modern subfield of probability, a theory of mathematics created by Pascal, Bernoulli, and Laplace for making educated decisions in the face of uncertainty. Financial mathematics is the specific application of these methods to make decisions in the face of uncertainty in the financial markets. This field is central to developing modern financial instruments in the economic markets.

Course Objectives

Financial Mathematics will provide students with a sound foundation in both the theoretical and pragmatic aspects of financial mathematics. The course provides an overview of how theoretical concepts and models are used in real-life applications. Students who desire to enter the actuarial or finance professions will be given a solid theoretical understanding of the essential topics in these fields. The course unit aims to enable students to acquire active knowledge and understanding of some basic concepts in financial mathematics, including stochastic models for stocks and pricing of contingent claims.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Acquire geometrical problem-solving and analysis skills which may be applied to diverse situations in mathematics, physics, and engineering.
CLO2	Discuss the conceptual framework of financial instruments related to financial mathematics.
CLO3	Identify and explain the different forms of business in Bangladesh, particularly their legal and financial reporting requirements.
CLO4	Explain and apply the difference between cash and profit and companies' book value and market value. Understand fundamental knowledge of Stochastic analysis, including Ito Formula and Ito Integration.
CLO5	Understand the Black-Scholes formula and get the concept of Introduction to actuarial mathematics and develop student abilities to create, derive, and apply mathematical models.

Course Contents

	Course Contents	Hours	CLOs
1	**Introduction to Finance:** Definition of finance, Types of finance, Major financial decisions, Goals of finance, Functions of financial institutions and financial market, Difference between the capital markets and the money markets.	5 Hrs.	CLO1, CLO2, CLO3
2	**Time Value of Money:** Definition and concepts-cash flow, Discounting and compounding, Present value, Future value, Annuities, Mixed streams, Effective annual interest rate and Amortization.	5 Hrs.	CLO2, CLO3
3	**Interest rates, Bond and Stock Valuation:** Interest rates and required returns, Term structure of interest rates, Important bond features, Different types of bond, Valuation fundamentals and bond valuation, Difference between debt and equity, Features of both common and preferred stock, Basic stock valuation using zero-growth, Constant-growth, and Variable growth models.	5 Hrs.	CLO1, CLO2, CLO3
4	**Overview of basic concepts in securities markets:** Exchange-traded markets, Over-the-counter markets, Forward contracts, Future contracts, Options, Types of traders, etc.	4 Hrs.	CLO4, CLO5
5.	**Stochastic Models for Stock Prices:** Continuous-time stochastic processes, Wiener processes, The process for a stock price, The parameters, Its lemma, and the lognormal property of stock prices.	5 Hrs.	CLO5
6	**Hedging Strategies and Managing Market Risk using Derivatives:** Financial derivatives, European call and put options, Payoff diagrams, Short selling and profits, Trading strategies, Straddle, Bull Spread, etc., Bond and risk-free interest rate, No arbitrage principle, Put-call parity, Upper and lower bounds on call options.	5 Hrs.	CLO4 , CLO5
7	**Binomial Option Pricing Model:** One-step binomial model and a no-arbitrage argument, Risk-neutral valuation, Two-steps binomial trees, Binomial model for stock price, Option pricing on binomial tree, Matching volatility σ with u and d, American put option pricing on binomial tree.	5 Hrs.	CLO2, CLO4
8	**Risk-neutral Portfolio:** Risk-neutral valuation, Replication and pricing of contingent claims.	3 Hrs.	CLO2, CLO4
9	**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 put option.	5 Hrs.	CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	♦	♦	♦	-	-	-	-	-	-	-	-
CLO3	♦	♦	♦	-	-	-	-	-	-	-	-	-
CLO4	♦	♦	-	♦	-	-	-	-	-	-	-	-
CLO5	♦	-	-	-	-	-	-	-	-	-	-	-

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Gitman L. J.,** Principles of Managerial Finance, *12th Edition, Adison Wesley,* 2007.
ii.	**Hull j.,** Options, Futures and Other Derivatives, 8th Edition, *Prentice-Hall,* 2012.
iii.	**Wilmott P., Howison S., and Dewynne J.,** The Mathematics of Financial Derivatives: A Student Introduction, *Cambridge University Press,* 1995.

Supplementary Readings

i.	**Atrill P., and McLaney E.**, Financial Accounting for Decision Makers, *7th Edition, Pearson,* 2013.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	**Teaching-Learning Strategy**	**Assessment Strategy**
CLO1	Lecturing, Students Activity and Group Discussion	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Assignment and Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Quiz/Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing, Questioning and Answer Questioning	Homework (Formative) and Final exam (Summative)

Course Title	Classical Mechanics	**ISCED Code**	0541-431
		Course Code	MTH 431
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Classical Mechanics is a major course for the undergraduate students of the B.Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentation, quiz, assignments, two midterms and comprehensive examinations. Classical Mechanics aims to provide a precise and consistent description of the dynamics of particles and the working of the systems of particles. In the present century, Classical Mechanics has come into wide use to denote this branch of physics in contradistinction to the newer physical theories, especially quantum mechanics.

Rationale

This course is designed to provide extensive knowledge about classical mechanics and know the techniques to solve different mathematical problems.

Course Objectives

Historically, a set of core concepts on space, time, mass, force, momentum, torque, and angular momentum were introduced in classical mechanics to solve the most famous physics problem, the motion of the planets. The principles of mechanics successfully describe many other phenomena encountered in the world. Conservation laws involving energy, momentum, and angular momentum provided a second parallel approach to solving many of the same problems. This course will investigate both approaches: Force and conservation laws. Our goal is to develop a conceptual understanding of the core concepts, a familiarity with the experimental verification of our theoretical laws, and an ability to apply the theoretical framework to describe and predict the motions of bodies.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Can achieve the knowledge on the dynamics of particles and the working of the systems of particles.
CLO2	Improve the analytical and computational ability in the mathematical physics problems.
CLO3	Determine the nature of the constraints and forces (conservative or non-conservative) for a given problem, and thereby identify the number of degrees of freedom and select appropriate generalized coordinates
CLO4	Obtain conserved quantities from symmetry properties of the Lagrangian using the concept of cyclic coordinates and be able to interpret the physical significance of these quantities (e.g., linear & angular momentum, energy) and apply Lorentz transformation to standard problems in special relativity. And describe particle dynamics in terms of covariant tensor equations based on Minkowski geometry.
CLO5	Find the equation of motion in terms of an effective potential and solve if for Standard central force problems, e.g., orbit equation, precession, etc and Find the canonical transformation for simple problems to make the problem easy to solve (cyclic coordinates). And test for the canonical condition using generating functions and Poisson brackets.

Course Contents

	Course Contents	Hours	CLOs
1.	Newtonian Mechanics.	5 Hrs.	CLO1, CLO2, CLO3
2.	Variational principles and Lagrange's Formulation.	5 Hrs.	CLO1, CLO2, CLO4
3.	Hamiltonian Formulation of Mechanics.	5 Hrs.	CLO1, CLO2, CLO4
4.	The Two-body Central Force Problem.	6 Hrs.	CLO1, CLO2, CLO5
5.	Rigid Bodies- Kinematics and Dynamics.	6 Hrs.	CLO1, CLO2, CLO5
6.	Canonical Transformations.	9 Hrs.	CLO1, CLO2,
7.	Special Relativity in Classical Mechanics.	6 Hrs.	CLO1, CLO2

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	-	-	-	-	-	-	-	_	-	-
CLO2	♦	-	♦	♦	-	-	-	_	_	_	-	-
CLO3	-	♦	♦	-	♦	♦	♦	-	-	-	_	_
CLO4	-	♦	♦	♦	-	♦	-	-	-	_	_	_
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	_	_	_

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Arnol'd, V.,** Mathematical Methods of Classical Mechanics, *Springer-Verlag, New York* 1978.
ii.	**Goldstein H.,** Classical Mechanics (2 ed.), *Addison-Wesley, USA,* 1980.
iii.	**Knauf A.,** Mathematical Physics: Classical Mechanics*, Springer, New York*, 2018.

Supplementary Readings

i.	**Whittaker E. T.,** A Treatise on the Analytical Dynamics of Particles and Rigid Bodies: with an Introduction to the Problem of Three Bodies (4th ed.), *Cambridge University Press, New York*, 1999.
iii.	**Fetter, A. L., and Walecka, J. D.,** Theoretical Mechanics of Particles and Continua. *McGraw-Hill, New York,* 1980.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing, Students Activity and Group Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Homework, Assignment, Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing and Group Discussion	Quiz/Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing, Questioning and Answer Questioning	Homework (Formative) and Final exam (Summative)

Course Title	Econometrics	**ISCED Code**	0311-432
		Course Code	ECO 432
Course Type	GED (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Econometrics is an optional GED programming course for undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations.

Rationale

Econometrics deals with the measurement of economic relationships. It integrates economics, mathematical economics and statistics with the objective of providing numerical values to the parameters of economic relationships. The relationships of economic theories are usually expressed in mathematical forms and combined with empirical economics. The econometrics methods are used to obtain the parameters' values, essentially the coefficients of the mathematical form of the economic relationships. The statistical methods that help explain the economic phenomenon are adapted as econometric methods. The econometric relationships depict the random behavior of economic relationships, which are generally not considered in economics and mathematical formulations.

Course Objectives

The main objective of **Econometrics** is to explain the behavior of the forthcoming period forecasting economic phenomena. Rather, it will aim to cover the old and established relationships among the variables or between the variables. Furthermore, this will help the students to establish new theories and relationships and test the hypothesis and estimation of parameters.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Analyze critically the basic elements of Econometrics in order to understand the logic of econometric modelling and be able to specify causal relationships among economic variables.
CLO2	Identify the relevant statistical sources in order to search for, organize and systematically arrange available economic data.
CLO3	Demonstrate the use with confidence of appropriate statistical methods and available computing tools in order to correctly estimate and validate econometric models
CLO4	Handle econometric prediction tools to estimate an economic variable's unknown or future values.
CLO5	Interpret adequately the results obtained in order to be able to write meaningful reports about the behavior of economic data.

Course Contents

	Course Contents	Hours	CLOs
1.	**The Nature of Econometrics and Economic Data:** Econometrics, Steps in empirical economic analysis, The structure of economic data, Causality and the notion of ceteris Paribus in econometric analysis.	3 Hrs.	CLO1, CLO2
2.	**The Simple Regression Model:** Definition of the simple regression model, Deriving the ordinary least squares estimates, Properties of OLS on any sample of data, Units of measurement and functional form, Expected values and variances of the OLS estimators, Regression through the origin.	6 Hrs.	CLO1, CLO2, CLO3
3.	**Multiple Regression Analysis:** Estimation, Motivation for multiple regression, The model with two independent variables, The model with k independent variables, Mechanics and interpretation of ordinary least squares, The expected value of the OLS estimators, The variance of the OLS estimators, Efficiency of	6 Hrs.	CLO1, CLO2, CLO3

	OLS: The Gauss-Markov theorem.		
4.	**Multiple Regression Analysis:** Inference, Sampling distributions of the OLS estimators, Testing hypotheses about a single population parameter: The t test, Confidence intervals, Testing hypotheses about a single Linear combination of the parameters, Testing multiple linear restrictions (The F Test), Reporting regression results.	6 Hrs.	CLO2, CLO3, CLO4, CLO 5
5.	**Multiple Regression Analysis:** OLS asymptotic, consistency, Deriving the inconsistency in OLS, Asymptotic normality and large sample inference, Asymptotic efficiency of OLS, Effects of data scaling on OLS statistics (Beta Coefficients), More on functional Form (Logarithmic functional forms, Models with quadratics, Models with interaction terms).	6 Hrs.	CLO1, CLO3, CLO5
6.	**Basic Regression Analysis with Time: Series Data:** The nature of time series Data, Some of time series Regression models: Static models, Finite distributed lag models, A convention about the time index, Finite sample properties of OLS under classical assumptions, Functional form, Dummy variables, and Index numbers, Trends and seasonality.	6 Hrs.	CLO2, CLO3, CLO4, CLO5
7.	**Further Issues in Using OLS with Time Series Data:** Stationary and weakly dependent time series, Stationary and nonstationary time series, Weakly dependent time series, Asymptotic properties of OLS, Using highly persistent time series in regression analysis, Highly persistent time series, Transformations on highly persistent time series, Decding whether a time series is I (1), Dynamically complete models and the absence of serial correlation.	9 Hrs.	CLO2, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	♦	♦	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	♦	♦	-	-	-	-	-	-
CLO3	♦	-	♦	♦	♦	-	-	-	♦	♦	-	_
CLO4	♦	♦	-	-	♦	♦	♦	-	-	♦	♦	-
CLO5	♦	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Jeffrey M. W.,** Introductory Econometrics: A Modern Approach, *Cengage Learning,* 2012.
ii.	**Joshua D. A., and Pischke J.-S.**, Mostly Harmless Econometrics: An Empiricistís Companion, *Princeton University Press,* 2009.
iii.	**Johnston J., and Di Nardo J.,** Econometric Methods, *McGraw-Hill,* 1996.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing and Students Activity	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Assignment, Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing, Students Activity and Group Discussion	Quiz/Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)

Course Title	Bioinformatics	**ISCED Code**	0542-433
		Course Code	STA 433
Course Type	GED (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Bioinformatics is an optional GED optional programming course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits** and **42 hours** of effective teaching in **14 weeks**. The course grades will be assessed through participation, class presentations, quiz, assignments, two midterms, and comprehensive examinations.

Rationale

Bioinformatics provides an overview of the most common statistical methods for molecular genomics, transcriptomics, and proteomics data analysis. It further provides the necessary information for solving complex biological problems and achieving a satisfactory score of the agriculture and health sectors' sustainable development goal (SDG) index.

Course Objectives

The course aims to introduce students to the rapidly evolving field of bioinformatics. Instead, it will aim to cover the most fundamental topics in the lectures, such as sequence alignment and pattern finding, and then explore some of the frontier areas. After completing this course, the students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data sets; they will understand how some of the commonly used bioinformatics tools work, how to use these tools effectively, and how to read and evaluate research articles in the field.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Analyze genomics, proteomics and transcriptomics datasets to provide the necessary information.
CLO2	Solve the complex biological problems that are associated with the genetic factors.
CLO3	Selec Demonstrate appropriate statistical algorithms for analyzing genomics, proteomics and transcriptomics datasets.
CLO4	Con Apply to the development of high yielding varieties and to achieve the satisfactory score of SDG index from the agricultural sector.
CLO5	Contribute to the discovery of new drugs/vaccines for the complex diseases and to achieve the satisfactory score of SDG index from the health sector.

Course Contents

	Course Contents	Hours	CLOs
1.	**Basic Genomics:** Introduction, Classification of genomics, Genes and Chromosomes, Cell division, Nucleic acid, Molecular Genetics (Marker, DNA sequence, SNPs), Genotype and Genotyping technology, Central dogma (DNA/Gene transcription, RNA translation and Protein synthesis).	9 Hrs.	CLO1
2.	**Basis Concept of Bioinformatics:** Concept of Bioinformatics, Importance, Scope and connectivity with statistics.	3 Hrs.	CLO2
3.	**Sequence Analysis:** DNA sequencing, Analysis of DNA patterns, Protein sequencing and Amino acids, Sequence formats, Sequence alignment, Overview of methods of sequence alignment. Dynamic programming algorithm for sequence alignment, Multiple sequence alignments. Statistical methods for aiding alignment, Some bioinformatics databases including GeneBank, NCBI, PDB, BLAST and FASTA.	9 Hrs.	CLO3
4.	**Phylogenetic Analysis of Sequence (DNA and Protein):** Motivation and background on phylogenetic, Distance and clustering approach, Likelihood methods, Parsimony, RNA-based phylogenetic methods, Phylogenetic tree estimation.	3 Hrs.	CLO2, CLO3, CLO4

5.	**Gene-Expression Data Analysis:** Introduction to different types of microarray gene expression data, Preprocessing (Transformation, Normalization, Image analysis and filtering). Identification of differential expressed (DE) genes in two or more groups using statistical test, Clustering and Classification for gene-Expression data analysis, Inferring genetic regulatory networks from microarray experiment with Bayesian networks. Modeling genetic regulatory networks using gene expression profile, Geneset enrichment analysis.	9 Hrs.	CLO1, CLO3, CLO5
6.	**Genome-wide Association Studies (GWAS):** Introduction, QTL and SNP analysis with Gene-Expression data, SNP analysis using contingency table, GWAS using linear mixed models and GeneABLE. Haplotype Estimation, Regional multilocus association models, Linkage disequilibrium and tagging, Practical guide to linkage disequilibrium analysis and tagging using Haploview.	9 Hrs.	CLO2, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	-	♦	-	-	-	-	-	-	-	-	-
CLO2	♦	-	♦	-	♦	♦	-	-	-	-	-	-
CLO3	♦	-	♦	♦	♦	-	-	-	♦	♦	-	_
CLO4	♦	-	-	-	♦	♦	-	-	-	-	♦	-
CLO5	-	♦	-	♦	♦	♦	♦	♦	♦	♦	♦	♦
CLO6	♦	♦		♦	♦		♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	**Lesk A.,** Introduction to bioinformatics, *Oxford University Press,* 2013.
ii.	**Brown S. M.,** Next Generation DNA Sequencing Informatics, *CSH press,* 2013.
v.	**Davis J. W.**, Bioinformatics and computational biology solutions using R and Bioconductor, *Journal of the American Statistical Association*, 2007.

Supplementary Readings

iii.	**Wu R., Ma C., and Casella G.,** Statistical genetics of quantitative traits: Linkage, maps and QTL. *Springer,* 2007.
ii.	**Rastogi R. C.,** Bioinformatics: Concepts, Skills and Applications, *CBS Publishers and Distributions*, 2009.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Lecturing, Students Activity and Group Discussion	Quiz/Homework (Formative) and Mid-Semester and Final exam (Summative)
CLO2	Lecturing and Discussion	Assignment and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO3	Lecturing and Group Discussion	Assignment, Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO4	Lecturing, Questioning and Answer Questioning	Quiz/Homework and Presentation (Formative) and Mid-Semester and Final exam (Summative)
CLO5	Lecturing, Answer Questioning	Homework and Final exam

Course Title	Honours Project	**ISCED Code**	0541-450
		Course Code	MTH 450
Course Type	Core (Optional)	**Course Status**	Theory
Course Hour	3.0 Hr./Week	**Credit Value**	3.0
Prerequisite	None	**Total Marks**	100

Course Description

Honours Project is a compulsory core course for the undergraduate students of the B. Sc. (Honors) program, which carries **3.0 credits**. It is compulsory for all students to work on a project intensively under a supervisor and submit a project report for evaluation. These projects should serve as expansions or applications of the mathematics or mathematical hypothesis in various honours courses and may require fieldwork and the use the simulation tools. Group projects and individual projects are both potential options.

Rationale

The **Honours Project** acts as an initial exploration of report writing and presentation preparation and develops their more profound understanding, Knowledge capabilities and attitudes. Each student/group is assigned diverse tasks involving substantial typing duties on computers and solving specific mathematical problems through analytically or computer simulations. Conversely, a group of students pursuing a Master's program will undertake a thesis, for which the Honours Project serves as a prerequisite course.

Course Objectives

Every student must engage in a project centered on a specific topic in mathematics. Through this endeavor, students cultivate their ability to analyze and formulate mathematical concepts, fostering the acquisition of comprehensive specialized skills and advanced knowledge. They develop a broad comprehension of fundamental mathematical concepts and methods, honing their essential skills in interpreting formulas and solving mathematical problems. Student may use different mathematical software to simulate and efficiently compute the mathematical problems to generate figures and data. Most importantly, the thesis proves they can describe the project-related activities and results in a well-written scholarly publication. Additionally, students adapt to independent scientific work by submitting reports in MS Word or LATEX and delivering PowerPoint or LATEX Beamer presentations. Moreover, the Honors Project prepares them to confidently tackle presentations and oral examinations before a panel of experts.

Course Learning Outcomes (CLOs)

On satisfying the requirements and successful completion of this course, students will have the knowledge and skills to-

CLO1	Compile a dissertation with a unique title and ideas generated by own self.
CLO2	Develop a comprehensive understanding of a specific area or topic within the field of mathematics through independent research and study.
CLO3	Demonstrate independent learning skills, including self-motivation, time management, and resourcefulness in conducting the project.
CLO4	Apply mathematical modeling and analysis techniques to real-world problems, making connections between theoretical concepts and practical applications.
CLO5	Develop critical thinking and creativity in approaching mathematical challenges and proposing innovative solutions and Utilize MS Word or LATEX and PowerPoint or LATEX Beamer effectively to produce a comprehensive project report and deliver a professional presentation.

Course Contents

Course Contents		Hours	CLOs
1.	The project supervisor provides a specific topic in Mathematics.	50 Hrs.	CLO1, CLO2, CLO3, CLO4, CLO5

Alignment of CLOs VS PLOs

Mapping of Course Learning Outcomes (CLOs) to Program Learning Outcomes (PLOs)

PLOs/ CLOs	PLO1	PL02	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO1	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
CLO2	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦
CLO3	-	-	♦	♦	♦	♦	♦	♦	♦	♦	♦	-
CLO4	-	-	♦	♦	♦	♦	♦	♦	-	-	-	-
CLO5	-	-	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦

♦: Aligned -: Not-aligned

Learning Materials

Recommended Readings

i.	Books and Journals related to research project topics.

Supplementary Readings

i.	Books and Journals related to research project topics.

Teaching-Learning and Assessment Strategy

Mapping of Course Learning Outcomes (CLOs) with the Teaching-Learning Strategy & Assessment Strategy

CLOs	Teaching-Learning Strategy	Assessment Strategy
CLO1	Students Activity and Slide Presentation	Quiz/Homework and Presentation
CLO2	Students Activity and Slide Presentation	Assignment and Presentation
CLO3	Students Activity and Questioning and Answer Questioning	Assignment and Presentation
CLO4	Students Activity and Questioning and Answer Questioning	Quiz/Homework and Presentation
CLO5	Slide Presentation and Students Activity	Quiz/Homework and Presentation