Curriculum and Syllabus

Bachelor of Science (4-year Honors) in Meteorology

Department of Meteorology
Faculty of Earth and Environmental Sciences
University of Dhaka

B.S. (Session 2023-2024)

1 July 2024

1. Introduction to the Institution

On the first day of July 1921 the University of Dhaka opened its doors to students with Sir P.J. Hartog as the first Vice-Chancellor of the University. The University was set up in a picturesque part of the city known as Ramna on 600 acres of land. At present the University consists of 13 Faculties, 83 Departments, 12 Institutes, 20 residential halls, 3 hostels and more than 56 Research Centers. The number of students and teachers has risen to about 37018 and 1992 respectively. The University of Dhaka is dedicated to the advancement of learning, and is committed to promoting research in all fields of knowledge. As there are plans for continuous expansion of facilities to open new avenues and opportunities, the course curricula are updated and new research projects are undertaken every year. As the pioneer and the largest seat of learning in the country, the University of Dhaka has taken the task to foster the transformation processes of the individual students and the country as a whole through its educational and research facilities keeping up with demands of the day.

The Department of Meteorology was established on 17th July 2016 under the Faculty of Earth and Environmental Sciences by the syndicate of Dhaka University in accordance with Dhaka University Ordinance and Regulations 1973, to meet the growing demands for skilled graduates in the field of Meteorology. The department aims to develop a cohort of professionals who can help foster public or private sector delivery of meteorological and related services. In Bangladesh, meteorologists are needed for weather forecasting, disaster mitigation, climate change assessment and adaptation and generating user tailored weather and climate services in the vital areas of the economy such as agriculture, fisheries, water resources sector, navigation, aviation, weather insurance, power and industries sectors, climate resilient infrastructure designs and development and saving ecology and environment. Due to the impacts of climate change and disaster risks on the livelihood, it is crucial to address the above areas for sustainable development of the country and achieving the Millennium Development Goals of the nation.

2. Introduction to the Program

2.1 Title of the Program

The title of the program is Bachelor of Science (B.S.) in Meteorology. The program is being introduced on the basis of increased need of graduates in the field of Meteorology and related areas of Atmospheric Sciences.

2.2 Duration of the Program

It is a 4 years' program with 8 semesters and it includes two semesters per year with the duration of 6 months each.

2.3 Eligibility for admission

A candidate has to fulfill the following minimum requirement to be considered eligible to get admitted in Meteorology:

Grade of H.S.C./Equivalent Examination	Mark of University Admission Test
Mathematics – A Physics – A Chemistry – A	Mathematics – 9 or Physics – 9 or Chemistry - 9

2.4 General objectives of the program

The objective is to produce expert meteorology graduates for full filling the increasing demands of meteorology graduates in the country. The program has been designed with basic to advance modules on Meteorology. Besides, the physics, mathematics and chemistry are included as foundation modules to prepare the background of the students for enabling them to capture the highly dynamical and heterogeneous atmosphere interfaced with land and sea and extremely inhomogeneous topography and land coverage.

2.5 Learning outcomes of the program:

Graduates will:

- Understand the physical basis and dynamical principles that govern a wide range of atmospheric phenomena and be able to express their knowledge and understanding clearly.
- Be able to describe and explain the origin and evolution of tropical and extra tropical weather systems across a range of scales.
- Know the basic physics and mathematics of application to understanding the atmosphere.
- Understand the weather and climate prediction techniques including their limitations.
- Learn to produce well-written, independently produced reports including the writing of Thesis.
- Learn to produce quality weather analysis charts and to interpret forecast products accurately and in a timely way, including verbally summarizing their details.
- Be able to participate effectively in team works.
- Understand the importance of early warning systems, how they are set up and their critical information relayed to users.
- Understand the processes important for Aviation Meteorology, produce charts and advisories for aviation.
- Know the relationship between agriculture and weather and climate; provide early warning and advisory to agriculture services for crop management.
- Know the basics of hydrology, hydrometeorology and their applications in water resources and flood modeling
- Will be able to analyze the causes of climate change and impacts, adaptation and mitigation strategy.
- They will have knowledge on the NWP modeling techniques and will be able run models for research and operational purpose.
- Will have knowledge to perform research in different areas of meteorology and applications.

3. Structure of Curriculum

Course credit: Total credit 140 (Theory+ Practical, viva and project).

Year 1: Total Credit (15 +17=32)

Semester 1 (15 credits)			Semester 2 (17 credits)		
Course Code	Course Name	Credit hour	Course Code	Course Name	Credit hour
MetTh 101	Physical Characteristics of Earth and The Atmosphere	3	MetTh 106	Physical Meteorology	3

MetTh 102	Linear Algebra	3	MetTh 107	General Circulation of Atmosphere	3
MetTh 103	Basic Physics for Atmospheric Science	3	MetTh108	Differential and Integral Calculus	3
MetLb 104	Programming Language - I	3	MetLb 109	Meteorological Instrumentation Lab + Field	3
MetLb 105	Physics Lab	3	MetLb 110	Programming Language - II	3
			MetV 111	Viva-voce	2
Total Credit		15	Total Credit		17

Year 2: Total Credit (18 +17=35)

Semester 3 (18 credits)			Semester 4 (17 credits)		
Course Code	Course Name	Credit hour	Course Code	Course Name	Credit hour
MetTh 201	Radiative Processes in Earth and Atmosphere	3	MetTh 207	Mathematical methods in Solving Meteorological Problems	3
MetTh 202	Applications of Statistics in Meteorology	3	MetTh 208	Dynamic Meteorology	3
MetTh 203	Differential and Integral Equations	3	MetTh 209	GIS and Remote Sensing	3
MetTh 204	Atmospheric Chemistry	3	MetLb 210	Programming Language - IV	3
MetLb 205	Applications of Statistics in Meteorology	3	MetLb 211	GIS and Remote Sensing Lab + Field	3
MetLb 206	Programming Language – III	3	MetV 212	Viva-voce	2
Total Credit		18	Total Credit		17

Year3: Total Credit (18 +17=35)

Semester 5 (18 credits)			Semester 6 (17 credits)		
Course Code	Course Name	Credit hour	Course Code	Course Name	Credit hour
MetTh 301	Boundary Layer Meteorology	3	MetTh 307	Ocean Atmospheric Interaction	3
MetTh 302	Fluid Dynamics	3	MetTh 308	Radar and Satellite Meteorology	3
MetTh 303	Synoptic and Mesoscale Analysis	3	MetTh 309	Tropical Meteorology	3

MetLb 304	Fluid Lab	3	MetTh 310	Cloud Physics	3
MetLb 305	Plotting and Analyzing of Meteorological Fields	3	MetLb 311	Radar and Satellite Meteorology Lab+ Field	3
MetLb 306	Synoptic and Mesoscale Analysis Lab	3	MetV 312	Viva-voce	2
Total Credit		18	Total Credit		17

Year 4: Total Credit (18+20=38)

Semester 7 (18 credits)			**Semester 8** (20 credits)		
Course Code	**Course Name**	**Credit hour**	**Course Code**	**Course Name**	**Credit hour**
MetTh 401	Research Methodology	3	MetTh 407	Climatology and Global Climate	3
MetTh 402	Weather and Climate Modeling	3	MetTh 408	Air Quality and Air Pollution Meteorology	3
MetTh 403	Hydrometeorology	3	MetTh 409	Weather Analysis and Forecasting	3
MetTh 404	Agrometeorology	3	MetTh 410	Severe and Hazardous Weather and Natural Disasters	3
MetTh 405	Aviation Meteorology	3	MetP 411	Research Project+Field	6
MetLb 406	NWP Models and Data Assimilation	3	MetV 412	Viva-voce	2
Total Credit		**18**	**Total Credit**		**20**

Grand Total 4-year credit (32+35+35+38=140)

Course and Credit Distribution

Course/Credit	**Total Theory**	**Total Practical**	**Total Field/Project and Viva**	**Total**
Course	28	14	05	**47**
Credit	84	42	14	**140**

4. Assessment System

Theory courses		
Marks Distribution		
Class Assessment	Class attendance	05%
	In-course assessment	25%
Course Final Examination	Subjective	70%
Total		100%

Practical courses		
Marks Distribution		
Class Assessment	Class attendance	10%
	In-course assessment	40%
Course Final Examination	Subjective	50%
Total		100%

Field Trip		
Marks Distribution		
Field Assessment		40%
Final Report	Field Report(s)	40%
	Presentation on Report(s)	20%
Total		100%

Project Works	
Marks Distribution	
Written Dissertation	60%
Defence	20%
Research Proposal	10%
Proposal Defence	10%
Total	100%

4.1 Marks of attendance

Attendance (%)	**Marks**
90 and above	05
85 to 89	04
80 to 84	03
75 to 79	02
60 to 74	01
Less than 60	00

4.2 In-course assessment for theory courses

(a) In-course Assessment may be done by taking class tests.

(b) The course teacher will announce the dates of in-course examinations at the beginning of the course (as per semester calendar). The in-course assessment will be of one-hour duration and the teacher concerned will be responsible to assess the students sitting in his/her course. There will be 2 tests for 3 credit course and 1 test for 2 credit course.

(c) Maximum duration of in-course test will be one class hour.

4.5. Course Final Examination (Theory and practical Courses)

(a) Student having 75% or more attendance on average (collegiate) are eligible to appear in the final examination.

(b) Student having 60-74% attendance are considered to be non-collegiate and will be eligible to sit for the final examination on payment on fine Tk. 1,000/= (One thousand).

(c) Student having attendance less than 60% will not be allowed to sit for the final examination but may ask seek readmission in the program.

(d) The duration of theoretical course final examinations will be as follows:

Credit	Duration of examination
4 credit course	4 hours
3 credit course	3 hours
2 credit course	2.5 hours

(e) Duration of practical examinations will be between 3-5 hours irrespective of credit hours.

The Class Test(s) for first In-course Assessment will be taken usually after covering 40% of the course topics and second In-course Assessment will be taken usually after covering 80% of the course topics. The Course Final Examination will be taken upon completion of the entire course. **In** Final Examination, each theory course will be evaluated by two teachers of the Department. If a single teacher teaches a course then the semester final test scripts must also be evaluated by two teachers, one of whom must be the course teacher, and another, a suitable second examiner who may be either from DU or outside DU. **In** the semester final examination if the difference of marks in any course is more than 20%, the script will be evaluated by a third examiner. The final marks obtained will be averaged of the nearest two marks, or third examiners marks if the difference between his/her marks and the two other examiner's marks are the same.

The total marks in a course will be converted into letter grade as under:

Numerical Marks	Letter Grade	Grade Point
80 above	A+	4.00
75 -79	A	3.75
70-74	A-	3.5
65 -69	B+	3.25
60-64	B	3.00
55 -59	B-	2.75
50 -54	C+	2.50
45 -49	C	2.25
40-44	D	2.00
Below 40	F	0.00

4.6. Degree Requirements

For the B.S. Honors degree, each student is required to:
i) Complete 140 credit hours without a F grade in any course
ii) Earn a minimum CGPA of 2.00: and
iii) Complete the program in maximum six consecutive academic years including the year of first admission into the program.

For appearing at each semester final examination, every student is to fill in examination entry form supplied by the Controller of Examination on payment of dues.

5. Structure of Courses

Year 1: Semester 1

MetTh 101: Physical Characteristics of Earth and the Atmosphere (03 Credit)

Rationale: The course introduces the basics of earth-atmospheric system, distribution of land and oceanic features and gradually builds up the information on atmospheric gaseous layers in the vertical and their physical structures and chemical composition.

Objectives: The objective is to provide the knowledge to the students about the basic features of land, ocean and atmosphere.

Syllabus Content: Sun-earth system: Motion of earth relative to sun in elliptic orbit, characteristics of spin of earth around on own axis. Causes of seasonal and latitudinal variation of Insolation. An overview on earth system-land, ocean and atmospheric systems, geographical coordinates and shape of earth, distribution of land and ocean in the earth system, topographical feature of continents and bathymetry of oceans, role of solar system in the formation of earth's energy variation and formation of weather and climate. Vertical structure of the atmosphere- distribution of vertical temperature and atmospheric layers. Composition of the atmosphere – major and trace gases, particulate matters. Elements of weather, weather phenomena, climate controls. Ocean currents, location of desserts and forests.

Learning Outcomes: The students will learn about the earth-ocean-atmospheric system, topography, role of solar system in atmospheric circulation and physical structure and chemical composition of the atmosphere.

Unit-wise title, subtitle and number of classes per unit:
Earth system-land, ocean and atmospheric systems: 1 credit (15 classes)
Role of solar system in the formation of earth's energy variation: 2 credit (24 classes)
Vertical structure and Composition of the atmosphere: 0.5 credit (06 classes)
Total class:45

Unit-wise learning outcome:
- Students will learn how four spheres interact with each other.
- They will also learn how energy from the sun drives the planet earth.
- They will know about the composite gases, vertical distribution of the atmosphere

Instruction strategy:
Lecture
Problem Practice in class
Live Streaming/virtual learning
Audio/Video Recording of the lectures

Recommended Text(s):
Aguado, E, and Burt, J. E 2010. Understanding Weather and Climate, 5/E, Prentice Hall, New Jersey, USA
Fundamentals of Physical Geography James F. Petersen, Dorothy Sack, Robert E. Gabler, Cengage Learning
Eric E. Small, The Earth System: An Introduction to Earth Systems Science
Aida Awad, Charles Dodd, Peter Selkin**,** Introduction to Earth Systems Science
Craig F. Bohren; Eugene E. Clothiaux, Fundamentals of Atmospheric Radiation, Wiley 2006.
Pidwirny, Michael J. Fundamentals of Physical Geography
Liou, An Introduction to Atmospheric Radiation. Elsevier Science 1981.

James Petersen, Dorothy Sack, Robert E. Gabler. Fundamentals of Physical Geography 2nd Edition.

MetTh 102: Linear Algebra (03 Credit)

Rationale: This course covers vectors, matrix theory and linear algebra, emphasizing topics useful in other disciplines. Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices.

Objectives: The objective is to use matrix techniques to represent and solve a system of simultaneous linear equations and understand the use of vectors in describing lines and planes in solid geometry.

Syllabus Contents: Matrix: Matrix Algebra, Determinant of Matrix; Concept on System of linear equations, Solution of System of linear equations using Matrix. Row reduction and echelon forms, Matrix operations, including inverses, Block matrices, Linear dependence and independence, Subspaces and bases and dimensions, Determinants and their properties, Cramer's Rule. Eigenvalues and eigenvectors, Diagonalization of a matrix, Symmetric matrices and Positive definite matrices. Solution of linear equations using Gaussian eliminations and LU decomposition method. Iterative methods: Jacobi method, Gauss Seidel method, SOR method and their convergence analysis.
Vectors: Geometric vectors, vectors in a coordinate plane, position vector, sum and difference of vectors, magnitude, unit vectors, graphs of the sum and difference. Dot product and Cross product: physical interpretation of the dot product(applications and extensions), orthogonal vectors, component and projection of vectors, cross product of basis vectors, right hand rule, physical interpretation of the cross product (applications and extensions) areas, scalar triple product, volume of a parallelepiped, coplanar vectors.

Learning outcomes: Students will have the concepts on matrices with different kind of matrix operations. They will be able to solve real life problems by converting them into a system of linear equations with the help of different matrix methods. They will have the knowledge to solve a system of linear equations by numerical iterative methods. They would also be able to interpret various operations of vectors.

Unit-wise title, subtitle and number of classes per unit:
Systems of linear equations: 1 credit (15 classes)
Diagonalization of a matrix: 1 credit (15 classes)
Vectors: 1 credit (15 classes)
Total Classes: 45

Unit-wise outcomes:
After the completion of the course, the students are expected to be able to

- Perform various matrix operations and solve system of linear equations using Cramer’s rule, Gaussian elimination and LU decomposition method
- Solve system of linear equations using iterative methods: Jacobi method Gauss Seidel, SOR methods
- Perform vector operations

Instruction strategy:
Lecture
Problem Practice in class
Live Streaming/Virtual learning
Audio/Video Recording of the lectures

Recommended Text(s):
Anton. Elementary Linear Algebra, 8th edition.
Introduction to Linear Algebra, Fifth Edition (2016), Gilbert Strang

Sheldon Axler, Linear Algebra Done Right

MetTh 103: Basic Physics for Atmospheric Science (03 Credit)

Rationale: This is the introductory course of Physics, which gives basic foundation of Newtonian Physics. This course is concerned with the behavior of physical bodies when subjected to forces or displacements, and the subsequent effects of the bodies on their environment. Classical mechanics describes the motion of macroscopic objects, from projectiles to parts of machinery, and astronomical objects, such as spacecraft, planets, stars and galaxies. This course also covers the basic fluid dynamics and properties of matter.

Objectives: Specific objective is to buildup foundation of classical Newtonian mechanics to the students and provide understanding of the properties of matter. Another objective is to give the students basic idea about how do fluids flow.

Syllabus Contents: Motion in two or three dimensions, e.g. projectile motion, circular motion. Notion of Force and Newton's laws of motion. Application of Newton's Law, Fundamental Forces, Frictional Forces, Conservation of momentum. Center of Mass and its Motion. Collision: Elastic and Inelastic collisions in one dimension. Impulse. Work and Energy. The Work-kinetic energy theorem. Conservative Forces and Potential Energy and their relation. Conservation of Energy. Rotational Kinematics, Moment of Inertia and its calculation, Radius of Gyration, Parallel-axis theorem, Perpendicular-axis theorem.
Surface Tension and Viscosity. Adhesive and Cohesive Forces, Molecular origin of Surface Tension, Excess pressure due to surface tension at an interface. Capillarity, Surface Tension of a Mercury Drop. Variation of Surface Tension with Temperature. Newton's Law of Viscosity, Poiseulle's Formula, Applications. Stokes Law. Terminal Velocity for Falling Bodies. Variation of Viscosity with Temperature. Fluid Dynamics. Streamline Flow, Turbulence. Reynold's Number. Bernoulli's Equation. Applications. Equation of Continuity, Euler's Equation.

Learning Outcomes: Students will have very good exposure to basics of classical mechanics. They will be able to solve problems on force, momentum, energy conservation, moment of inertia, rotational kinematics. They will acquire the basic knowledge of fluid dynamics, which will help them understand the fluid motion in the atmosphere and ocean. Students will predict by the laws of classical mechanics how it will move in the future (determinism) and how it has moved in the past (reversibility).

Unit-wise title, subtitle and number of classes per unit:
Force and momentum: 1 credit (13 classes)
Work and energy: 1 credit (12 classes)
Surface tension and viscosity: 1.5credit (20 classes)
Total 45 classes

Unit-wise learning outcome:
- Students will have very good exposure to basics of classical mechanics.
- They will be able to solve problems of energy conservation, moment of inertia, and rotational kinematics.
- They will learn problems related to surface tension, viscosity, fluid flow and equations that provides clues for future prediction

Instruction strategy:
Lecture
Problem Practice in class
Practical Laboratory
Live Streaming/virtual learning

Audio/Video Recording of the lectures

Recommended Text(s):
David Halliday& Robert Resnick Physics for Students of Science & Engineering Pt 1&2 combine
David Halliday& Robert Resnick, Fundamentals of Physics
Robert Resnic, David Halliday and Keneth S. Krane: Physics, Vol-I & II
Giasuddin Ahmed: Properties of Matter-
Giasuddim Ahmed – Electricity and Magnetism
Giasuddin Ahmed, Physics Practical
Robert Resnic, David Halliday and Keneth S. Krane: Physics, Vol I
Properties of Matter, B. H. Flower
Mechanics; Symon, KR
General Properties of Matter, Newman, FH and Searle, VHL
Gases, Liquids and Solids; D. Tabor, Cambridge University Press, Cambridge
The Mechanical Properties of Matter: M. T. Sprackling.
The General Properties of Matter: F. W. Newman and V. H. L. Searle. , Edward Arrold Publishers, London.
Properties of Matter: S. Ahmed and A. K. Nath.

MetLb 104: Programming Languages - I (03 Credit)

Rationale: This module provides the basics of computer systems and programming which is essential for the meteorology students.

Objectives: The objective to teach the student computer programming. But this is very basic which will help the students to learn programming.
Syllabus Contents:

- Fundamental of Computer Programming: Programming basics, Introduction to FORTRAN, How to write, process and run programming, Programming and Problem Solving.
- Problem-solving techniques using computers: Flowcharts, Algorithms, Pseduo code.
- Programing in FORTRAN: Syntax and semantics, Data Types, Constants, and Variables, Operation and Intrinsic Functions, Expressions and Assignment Statements, Numeric, Relational and Logical operations, Operator Precedence, single and mixed mode arithmetic, Fortran I/O and External files.
- Control Constructs: IF Constructs, Nested and Named IF Constructs, SELECT CASE Construct, Do Loops, Named and Nested Loops, Implied do loops.
- Arrays and Array Operations: Declarations, Array Constructors, Array Sections, Array operations, Allocatable Arrays.
- Programming Units: Types of Programming Units, Main Program, External Procedures, Internal Procedures, Modules, Subroutines, Functions, Recursion.

Learning Outcomes: Students will gain some knowledge about operating systems and be able to install them. They will be capable use few programming languages.

Unit-wise title, subtitle and number of classes per unit:
Operating systems and Fortran: 3 credit (45 classes)
Total class: 45

Unit-wise learning outcome: After the completion of the course, the students are expected to be able to –

- Describe programming language: FORTRAN
- Explain any problem using Flowcharts, Algorithms and Pseudo code
- Define variables, constants, data and perform various loops

Instruction strategy:

Lecture
Programming in Computer Lab
Live Streaming/virtual learning
Audio/Video Recording of the lectures

Recommended Text(s):

- Stephen J Chapman, Introduction to FORTRAN 90/95.
- Programming in Fortran, Schaum's Outline Series.
- Gordon B. Davis & Thomas R. Hoffmann, FORTRAN 77: A Structured, Disciplined Style.

MetLb 105: Physics Lab (03 Credit)

Rationale: This is the introductory course to demonstrate the basic foundation of Newtonian Physics, capillarity and viscosity.

Objectives: Specific objective is the demonstration of the laws of classical Newtonian mechanics, capillarity as well as viscosity of a viscous fluid to the students.

Syllabus Contents:
1. To determine the modulus of rigidity of a wire by the method of oscillations (dynamic method).
2. To determine the spring constant and effective mass of spring and hence calculate the rigidity modulus of the material of the spring.
3. To determine the value of *g*, acceleration due to gravity, by means of a compound pendulum.
4. To determine the surface tension of water by capillary tube method.
5. To determine the co-efficient of viscosity of a liquid by its flow through a capillary tube.
6. To verify Stoke's law and hence to determine the viscosity of a liquid (glycerine).

Learning Outcomes: Students will understand the basics of classical mechanics more. They will be able to determine the value of *g*, and verify Stoke's Law. They will better understand the characteristics of a viscous fluid which will eventually help them to understand motion and the terminal velocity of raindrop in the air.

Unit-wise title, subtitle and number of classes per unit:
Mechanics: 1.5 credit (25 classes)
Properties of matter: 1.5 credit (20 classes)
Total class:45

Unit-wise learning outcome:

- Students will understand the basics of classical mechanics. They will be able to determine *g.*
- They will be able to better understand the laws related to elasticity, spring force, viscosity and terminal velocity of raindrops
- They will be able to determine the value of g, and verify Stoke's Law. They will better understand the characteristics of a viscous fluid which will eventually help them to understand motion and the terminal velocity of raindrop in the air.

Instruction strategy:
Lecture
Practical Laboratory
Live Streaming/virtual learning
Audio/Video Recording of the lectures

Recommended Text(s):
Giasuddin Ahmed, Physics Practical
Tyler, F; Laboratory Manual of Physics

Worsnop, BL and Flint, HT; Advanced Practical Physics