Tribhuvan University

Institute of Science and Technology

2016 (Revised version)

Structure of four year B. Sc. Meteorology course

Year	Theory	FM	Practical	FM
Second	Physical Meteorology and General Hydrology (50+50) MET 201	100	Physical Meteorology and General Hydrology Practical MET 202	50

Second Year

Physical Meteorology and General Hydrology

Course Title: Physical Meteorology and General Hydrology
Course Number: MET 201 Full Marks: 100
Nature of Course: Theory Pass Mark: 35

Group A: Physical Meteorology (Theory)

Course Objectives:

This course provides basic knowledge of the quantitative treatment of the energy processes in the atmosphere. The relationship between the atmospheric variables is derived in the form of basic equations. Some of the processes going on the atmosphere are treated quantitatively. In General Hydrology this course is providing the general hydrological processes.

Course content:

Meteorological Variables: Introduction to the conventional measurements of different parameters (Rain gauges, Thermometer, Anemometers, Evaporation pan, Solar radiation, Sunshine duration, Soil temperature, Dry bulb and wet bulb temperature), Automatic Weather Station, Weather Satellite, Radar, Radiosonde and Pilot Balloon. 10 hrs

The atmosphere: Physical foundation (Introduction of thermodynamics, radiation, Newton's law), units and dimension, composition of the atmosphere (The composition of dry air, Water vapor in the atmosphere, Carbon dioxide, Interplanetary Gas), Vertical Division of the atmosphere (Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere). 10 hrs

Atmospheric Pressure: The nature and units of the atmospheric pressure, the measurement of atmospheric pressure, Mercury barometers, corrections for standard conditions, Aneroid barometers, barographs, Variation of pressure with altitude, Reduction of pressure to standard levels. 10 hrs

Equation of state: Variable of state, Derivation of Charles' Law and Boyle's Law, equation of state of an ideal gas, mixture of gases 7 hrs

Heat and Energy: specific heat capacity, internal energy, conservation of energy, adiabatic processes, Poisson's equation, entropy and the second law of thermodynamics, Thermodynamics of moist air (equation of state of moist air, changes of phase and latent heat, The Clausius-Clapeyron equation, adiabatic processes of saturated air. 10 hrs

Moisture variable: Brief introduction of vapor pressure, absolute humidity, mixing ratio, specific humidity, relative humidity, virtual temperature, dew point temperature, lifting condensation level (LCL), wet-bulb temperature, wet-bulb potential temperature, equivalent temperature and equivalent potential temperature. 7 hrs

Thermodynamic diagram: Principle of equal area transformation, the Emagram and the Tephigram. 7 hrs

Hydrostatic Equilibrium: Hydrostatic equation, hydrostatic of special atmosphere (the homogenous atmosphere, the isothermal atmosphere, the constant lapse rate atmosphere, the dry adiabatic atmosphere and the US standard atmosphere. 7 hrs

Hydrostatic stability and convection: Dry and moist adiabatic lapse rate, the parcel method, the slice method. 7 hrs

Text Book

- Hess, S. L., An Introduction to Theoretical Meteorology

Reference Books

- George J. Haltiner and Frank L. Martin, Dynamical and Physical Meteorology, McGraw-Hill Book Company.
- Compendium of Physical Meteorology class- IV, WMO, Geneva.
- David G. Andrews, An Introduction to Atmospheric Physics, Cambdrige University Press, 2000.

Group B: General Hydrology (Theory)

Introduction: Definition, and scope of hydrology**,** hydrological cycle and water balance equations**,** development of hydrological study in Nepal 2 hrs

Precipitation: Causes, forms and types of precipitation, Measurement of Rainfall (Recording, non-recording, rain data logger, weather radar, totalisers), network design (optimum number of rain-gauge station, ideal location), estimation of missing data (arithmetic, normal ratio, weighted average of four station, interpolation from isohyetal maps, regression method), double mass curve, computation of average rainfall (isohyetal, Thiessen polygon, arithmetic), drought, history and status of precipitation measurement in Nepal. 5 hrs

Hydrological Losses: Initial losses (Interception and depression storage) Evaporation process Meteorological parameters (Radiation, Temperature, Vapor pressure, Humidity, Wind), Energy Budget methods and Mass transfer approach (Dalton's law), Evaporimeters, Evapotranspiration, Actual evapotranspiration and Lysimeters, Potential Evapotranspiration (Thornthwaite, Blaney Criddle, Penman's equation), Infiltration, Factors affecting Infiltration, Horton's equation, Infiltration indices (Φ and W), Infiltrometers. 5 hrs

Surface Runoff : Drainage basins and its quantitative characteristics, Factors affecting runoff from a catchment, Rainfall - Runoff relationship, Stream gauging (selection of sites, types of gauges and measurement), Stream flow measurement by area velocity method (current meters, and floats), Stream flow computation by slope area method, Development of Rating curve and its uses, Estimation of monthly flows from rainfall. 5 hrs

Hydrograph: Hydrograph concept, factors affecting of hydrograph and shape of hydrograph, component of hydrograph, base flow separation, effective rainfall, theory of unit hydrograph, assumption, uses and limitation of unit hydrograph, derivation of unit hydrograph. 5 hrs

Ground water: Introduction (zoning of subsurface), occurrence of ground water, types of aquifers, aquifer parameters (porosity, specific yield, specific retention, storage coefficient, permeability, transmissivity) ground water basin, Darcy's law its range validity, field measurement of permeability. 5 hrs

Snow and Glacial Hydrology: Introduction of snow and ice, snow measurement and water equivalent, physical properties and metamorphism of snow, densification of snow, snowline, snow albedo, snow avalanche, snow cover delineate and snow cover determination, snow runoff and snow melt, Heat budget on snow, definition and types of glacier and Himalayan glaciers, zones and equilibrium line in a glacier and their importance, glacier formation, mass balance and measurement, , glacier ice and debris, snow accumulation, ablation zone, mass balance of snow, snow and glacier fed rivers of Nepal, glacier lake outburst flood (GLOF) historical background, mechanism of GLOF and mitigation measures, development, identification and prioritization of potentially dangerous glacial lakes, climate and glacier response, remote sensing of glacier and glacial lake. 10 hrs

Text Books

- Ven Te Chow, David R. Maidment and Larry W. Mays, Applied Hydrology, McGraw-Hill International Editions.

Reference Books

- David Keith Todd, Groundwater Hydrology, Second Edition 1995, John Wiley & Sons.
- H.M Raghunath, Hydrology Principles, Analysis, Design 1997, New Age International Publications
- KN Mutreja, Applied Hydrology, 1986, Tata McGraw-Hill Publication Company Limited.
- Reddy JR Hydrology, 2010, Laxmi Publications
- S Subramanya, Engineering Hydrology, Tata McGraw-Hill Publication Company Limited, 2012.
- Peterson W.S.B. and K.M. Cuffey, 2010, The Physics of Glacier, Elsevier Publication

Physical Meteorology and General Hydrology

Course Title: Physical Meteorology and General Hydrology

Course Number: MET 202 Full Marks: 50

Nature of Course: Practical Pass Mark: 20

Group A: Physical Meteorology (Practical)

Practical 1: Computation of lapse rate of given data (using radiosonde data), RAOB

Practical 2: Estimation of mixing ratio, RH.

Practical 3: Estimation of LCL and CCL from tephigram

Practical 4: Determination of stability of the atmosphere using various meteorological parameters

Practical 5: Plotting of vertical height vs temperature graph from given data and interpret

Practical 6: Calculate a weighted average of annual total rainfall of a particular basin for the period of 30 years.

Practical 7: Measure the degree of correlation between rainfall, humidity, surface air temperature.

Practical 8: Find out the auto correlation of temperature of a given station for 30 years.

Practical 9. Estimation of Surface lapse rate using various surface Meteorological data.

Group B: General Hydrology (Practical)

Practical 1: Estimation of missing rainfall data

Practical 2: Preparation of rainfall mass curve and hyetograph

Practical 3: Isohyetal, Thiessen Polygon method and arithmetic average of rainfall depth

Practical 4: Double mass curve Analysis

Practical 5: Drought analysis (using precipitation data)

Practical 6: Optimum number of raingauge stations

Practical 7: Frequency analysis of rainfall

Practical 8: Preparation of infiltration capacity curve

Practical 9: Calculation of Φ and W

Practical 10: Determination of Horton's constant

Practical 11: Estimation of evaporation loss from reservoir.

Practical 12: Measurement and estimation of evaporation from different method

Practical 13: Estimation of potential evapotranspiration from Blaney Criddle and Thornthwaite methods

Practical 14: Estimation of potential evapotranspiration from Penman method

Practical 15: Preparation of hydrograph, base flow of hydrograph and preparation of Unit hydrograph.

Practical 16: Calculation of aquifer parameters (porosity, specific yield, hydraulic conductivity permeability)

Practical 17: Measurement of river by using surface float and current meter

Practical 18: Preparation of rating curve

Practical 19: Relationship between snow albedo and snow ablation

Practical 20: Energy balance and mass balance of snow and glacier