Tribhuvan University
Institute of Science and Technology
Three year B. Sc. Meteorology course of study
2052

Course Title: Physical Meteorology **Full Marks:** 50
Course No.: MET 311 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Theoretical **Year:** I

Course Objectives:

- This course provides the students a basic knowledge of the quantitative treatment of the energy processes in the atmosphere. The relationship between the basic atmospheric variables including the moisture variables is derived in the form of basic equations. Some of the processes going on in the atmosphere are treated quantitatively. A simplified quantitative description of the atmosphere is also treated.

Introduction of the Atmosphere: Physical foundation, units and dimensions, characteristic of the atmosphere, various layers of the atmosphere. **2 hrs.**

Equation of State: Variables of state, equation of state of an ideal gas, mixture of gases (Dalton's law). **3 hrs.**

Principles of Thermodynamics: Work, heat, first law of thermodynamics, internal energy and specific heat capacity of an ideal gas, changes in internal energy and its application of the atmosphere, adiabatic process (Potential Temperature), entropy and the second law of thermodynamics, numerical. **8 hrs.**

Moisture Variables: Vapour pressure, saturation vapour pressure, absolute humidity, relative humidity, specific

humidity, mixing ratio, virtual temperature, dew point temperature, wet bulb potential temperature, equivalent temperature, equivalent potential temperature, lifting condensation level, numerical. **8 hrs.**

Equation of State of Moist Air: Change of phase and latent heat, Clausius:- Clapeyron equation, adiabatic processes of saturated air, nimericals. **7 hrs.**

Thermodynamic Diagrams: General consideration, The Emagram, The T-phi gram. **3 hrs.**

Hydrostatic Equilibrium: Hydrostatic equation, height computation for upper level, hydrostatics of special atmospheres; homogeneous; isothermal; constant lapse rates, dry adiabatic, standard atmosphere, numericals. **7 hrs.**

Hydrostatic Stability: Stability criteria; Absolute stability, absolute instability; conditional instability, latent instability, Parcel method, Slice method, entrainment. **8 hrs.**

Atmospheric Optical Phenomena: Halo, rainbow, visual range, coronas. **2 hrs.**

Condensation and Precipitation: Condensation, evaporation and sublimation, size spectrum of aerosol particles, solute effect, ice nucleation, growth by coalescence, atmospheric electricity. **7 hrs.**

Text Books:

1. John G. Albright, ***Physical Meteorology***, Prentice Hall Inc., New York, 1943.

Reference Books:

1. H.R. Byers, ***General Meteorology***.
2. R.A. Antes, H.A. Panotsky, J.J. Kahir & A Rango, ***The Atmosphere***.
3. ***Compendium of Meteorology*** (Class I and II), Volume I, Part 2.
4. ***Physical Meteorology*** (WMO Number 364)
5. S.L. Hess, ***Introduction to Theoretical Meteorology***, 1st Ed., Holt, Rinehart and Winston, New York, 1959.

Course Title: Climatology **Full Marks:** 50
Course No.: MET 312 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Theoretical **Year:** I

Course Objectives:

- The aim of the course is to provide an introduction to climatology for the students of Meteorology. In order to familiarize them about the physical causes of the climate and the variation of climate in space and time.

Definition and Scope of Climatology: Purpose of study; definition of climatology, climate and weather, elements of climate and statistics to describe them. **1 hrs.**

Solar Radiation and Terrestrial Heat Balance: The incoming solar radiation in the absence of the atmosphere; depletion of incoming solar radiation by the earth's atmosphere; diffuse sky radiation; general survey of terrestrial heat balance. geographical distribution of solar and out going radiation. **3 hrs.**

Spatial and Temporal Variation of Temperature over the Earth: Temperature at the earth's surface as a function of latitude; the effect of land and sea on the temperature distribution at the earth's surface; the annual variation of temperature; the diurnal variation of temperature; the temperature distribution at higher altitudes; lapse rate to temperature. **3 hrs.**

Spatial and Temporal Variations of Wind and Pressure: Survey of wind and pressure distribution at the earth's surface; the effect of land and sea on the wind and pressure distribution; Monsoon circulation; The climatic effects of ocean currents, wind and pressure distribution at higher levels. **4 hrs.**

Hydrometeors: Annual precipitation over the earth's surface; the effects of continents and oceans on the distribution of precipitation; precipitation and altitude; the annual variation of precipitation; The diurnal variation of precipitation, snow, fog, thunderstorm. **5 hrs.**

Air Masses, Cyclones and Fronts: Air masses:- Definition, source regions of air masses, types of air masses, modification of air masses. Fronts: definition and classifications. cyclones and anticyclones. **3 hrs.**

Climatic Classification: Purpose of climatic classification; Various systems of climatic classification:- Koeppen's classification and the Thornthwaite's classifications **4 hrs.**

Description of the Climatic Type: The tropical rainy climate, the dry climate, the warm temperate rainy climate, the snow forest climate, the polar climate. **2 hrs.**

Regional Climatology of Asia: Physical feature, mean distribution of pressure and wind; air masses, fronts, tropical cyclones and anticyclones and climatic regions. Western disturbances. **4 hrs.**

Climate of Nepal: Climate of Nepal **6 hrs.**

Climatic Changes: Climatic changes through geological time; evidences of climate change; theories of climate change; impacts of climate change. **6 hrs.**

Monsoon: Different meanings, concepts and the origin of Monsoon; Indian Southwest Monsoon. Role of Tibetan Anticyclone on Monsoon circulation, onset criteria of monsoon and withdrawal of monsoon. 10 hrs.

Text Book:

1. Glenn T. Trewartha, ***An Introduction of Climate***, McGraw Hill, Book Co. Inc., New York, 1954.

Reference Books:

1. E.T. Stringer, ***Techniques of Climatology***, Published by W.H. Freeman & Co., Sanfrancisco.
2. Bernhard Haurwitz and James M. Austin, ***Climatology***, McGraw Hill Book Company, Inc., New York, 1944.
3. Critchfield, H.J., 1979, ***General Climatology***, 3rd Ed., Prentice Hall of India Pvt. Ltd., New Delhi.

Course Title: Meteorological Practical **Full Marks:** 50
Course No.: MET 313 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Practical **Year:** I

Course Objectives:

- The purpose of the course in to familiarize the students about the surface and upper air meteorological instruments; the statistical methods used in climatological determination of water balance and delineation of climates by different methods.

Meteorological Practicals: Network density, Norms for installation of precipitation station, installation criteria for meteorological stations. **6 hrs.**

Inspection Techniques: Fortin's Barometer (to prepare a correction table), Kew Pattern Barometer (to prepare a correction table); reduction to sea level (Fortin's and Kew Pattern Barometers), height differences between two stations using hydrostatic equation, Lag Coefficient of thermometer, Altimetry, Asmann psychrometer and humidity chart, analysis of solar radiation charts, preparation of wind roses. **3×9 hrs.**

Climatology: Use of moving average technique in meteorological data, probability analysis, climatic classification by both Koeppens and Thronthwaites methods, Analysis of evaporation data, preparation of weekly and monthly climatological summaries from climatological data, water balance by Thornthwaites method, preparation of monthly means from a land station (Climate) including its general code. 3×16 hrs.

Text Books:

1. World Meteorology Organization No. 8, ***Guide to Meteorological Instrument and Observing Practices***, WMO, Geneva, Switzerland, 1983.

Reference Books:

1. Ratauack, WMO Publication, ***Compendium of Lecture's Notes for class IV Meteorological Personnel***.
2. Meteorological Office, ***Observer's Handbook***, Her Majesty's Stationery Office, London.

Course Title: Synoptic Meteorology, Agricultural Meteorology and Fluid Mechanics
Full Marks: 100
Pass Marks: 40
Year: II
Course No.: MET 321 (Major/Minor)
Nature of the Course: Theoretical

Course Objectives:

- The purpose of Synoptic Meteorology is to familiarize the students with the techniques to analyse weather conditions for forecasting.

Synoptic Meteorology:

Air and Fronts: Composition and vertical distribution of the atomsphere; air masses; main frontal zones; some general properties of fronts. **3 hrs.**

Forntal Depressions: Formation of frontal depressions; warm front; cold front, occlusion, summary of frontal characteristics, general distribution of weather in frontal zone, families of frontal depression, upper winds over frontal depressions, secondary fronts. flights through frontal depressions, frontolysis and frontogenesis. **9 hrs.**

Other Depression: Cause of western disturbances, thermal depressions, oragraphic depressions, secondary depressions, tropical revolving storms, tornadoes, trough of low pressure. **5 hrs.**

Anticyclones: Types of anticyclones, general properties of anticyclones, cold anticyclones, warm anticyclones, col, ridge of high pressure **5 hrs.**

Elements of Forecasting: Introduction, analysis of surface chart, analysis of upper air chart; preparation of forecast surface chart, preparation of forecast upper air chart, composite forecast preparation of area, route and flight forecasts, local and Terminal aeordrome forecasts, forecasting in the Tropics in general, various-approaches in forecasting. **9 hrs.**

Thunderstorms: Condition favourable for thunderstorms, the cellular structure of thunderstorm, further characteristics, flight through thunderstorm, electrical phenomena associated with thunderstorm. **5 hrs.**

Visibility of Fog: Significance of visibility, types of fog and its formation, artificial dispersion of fog. **2 hrs.**

Ice accretion of Aircraft: Introduction, forms of air frame icing, factors affecting the form of air frame icing, air frame icing in relation to cloud forms, effects of air frame icing on performance, engine icing, flight procedures in air frame icing conditions. **5 hrs.**

Some Characteristics of High Altitude Flight: Introduction, air density and aircraft performance, jet streams, clear air turbulence (CAT), condensation trails, pressure pattern flying. **6 hrs.**

Wind and Pressure: Global wind and pressure distribution (winter and summer) (Equator to Pole). **2 hrs.**

Temperature: Global temperature distribution and rainfall distribution in Nepal. **1 hrs.**

Rainfall: Global rainfall distribution and rainfall distribution in Nepal. **1 hrs.**

Agricultural Meteorology:

- understanding the physical principles of meteorological parameters such as radiation, temperature, precipitation, etc. together with the understanding of life processes of plants and animals in relation to meteorological variables, By understanding the relationship between weather and crop yield, it is possible to predict and maximize crop yield in advance. Artificial modification of climate inside a greenhouse to introduce new varieties of agriculture is another important research field of modern agro-meteorology. The prime objectives of the course are to highlight these aspects.

Meaning of Agricultural Meteorology: Background; Introductory plant physiology and animal physiology; natural plants and wild life; Influence of weather on agriculture; long-term and short-term effects and growth, land use strategy and Agro-climatology. **9 hrs.**

Climatological Factors Affecting Agriculture: Radiation; temperature, moisture; wind. **3 hrs.**

Agricultural Meteorology Plant Growth: Seed germination; pollination; crop development and growth; crop pests and diseases. **5 hrs.**

Agricultural Climate: Climate for rice, wheat, corn, soyabean, tomato, apple, sugarcane, tea and coffee. **5 hrs.**

Weather ad Plant Diseases: Weather and pathogens; weather and the host; forecasting disease development. **5 hrs.**

Text Books:

1. R.G. Barry and A.H. Perry, ***Synoptic Climatology***, Matheun and Co. Ltd., London, 1973.
2. Smith, Lionel P. : Methods in Agricultural Meteorology.

Reference Books:

1. Byers, H.R., ***Synoptic Meteorology***, New York, McGraw Hell, 1937.
2. ***Air Weather Service (MAC) United States Air Force***, 1071-Atkinson Published.
3. Professor T.N. Krishnamurti, Class I and 11 Meteorological Personnel (WMO), ***Compendium of Meteorology for Use***.
4. Her Majesty's Stationary Office, ***Handbook of Aviation Meteorology***, London.
5. Chang : ***Agriculture Meteorology***.
6. Landsberg : ***General Climatology***.
7. ***Guide to Agricultural Meteorologycal Practices***, Lo. Mo. 134, WMO, Geneva.
8. Vikerich, ***Agriculture Meteorology***, Israil Programme for Scientific Translation Jerusalem.
9. Slatyer, ***Plant-Water Relationship***, Academic Press, New York.
10. William P. Lawry, ***Weather and Life, An Introduction to Biometerology***, Academic Press Inc.

Course Title: Fluid Mechanics
Course No.: MET 322 (Major/Minor)
Nature of the Course: Theoretical

Course Objectives:

- Meteorology being a science of atmospheric the study of fluid dynamics is an essential. Further more, this is also useful for the hydraulics in hydrological science. This course has been developed to provide understanding motion of fluid in atmosphere and land surface to the students.

Fluid Mechanics:

Definition and Properties of Fluids: Definition, properties, classification of fluids, (liquid and gases); fluid mechanics and its branches; fluid mechanics, hydro-mechanic, hydrostatics, hydro kinematics; hydro dynamics and hydraulics; dimensions, units and system of measurement. **5 hrs.**

Kinematics of Fluid Flow: Introduction; methods for describing fluid motion; lines of flow; path line, stream law, stream tube, streak filament line, potential line steady and unsteady flow; uniform and non-uniform flows; laminar and turbulent flows; compressible and incompressible flows; rational and irrational flows; one, two or three dimensional flows; equation of continuity for three dimensional velocity of fluid particles, acceleration of flows; connective and local acceleration, normal acceleration, different types of displacement of fluid particles, translation, rotation, distortion and deformation; equation of stream line: stream function: physical I and mechanical 'concepts; velocity function-, circulation. **14 hrs.**

Basic Equation of Fluid Flow: Introduction; various form of energies present in fluid flow; energy equation: Bernoulli's theorem and its statement; Bernoulli's theorem for liquid: general energy equation for steady flow and derivation of Bernoulli's equation; Euler's equation of motion and derivation of Bernoulli's equation; discussions on, assumption underlying Bernoulli's equation; some practical application of Bernoulli's equation, momentum equation. **14 hrs.**

Some Concept of Atmospheric Fluid Dynamics: Fluid measurement of acceleration in a rotating coordinate system; equation of fluid motion in rotating coordinate system; continuity equation; common approximation of Atmospheric fluid dynamics: (a) the baratropic fluid, (b) the hydrostatic approximation, (c) the horizontal flow approximation, (d) the geostrophic approximation; the Prudman-Taylor theorem; dynamics of vorticity; (a) definition of verticity; (b) the conservative properties of vorticity, and (c) dynamics of vorticity. in a rotating co-ordinate system. **12 hrs.**

Text Books:

1. S. Eskinazi – ***Fluid Mechanics of Thermodynamics of our Environment***, Academic Press, New York, 1975.
2. Jagdish Lal, ***Fluid Mechanics***.

Reference Books:

1. Manohar Lal, ***Fluid Machanics***.
2. Frainics, J.R.D., ***Fluid Mechanics***.
3. Streeter, V.L., ***Fluid Mechanic***.
4. Pal Arya, ***Introduction of Micrometeorolua***, Academic Press Inc.
5. Roland B. Stull', ***An Introduction of Boundary Layer Meteorology***, Kluweh Academy Publishers.
6. Roger G. Barry and Richard J. Chorley, ***Atmosphere, Weather and c@***, Mathuen and Co. Ltd., London.
7. G.J. Haltimer and F. Martin, ***Physical Meteorology***, McGraw, Hill Book Co., New York.

Course Title: Meteorological Practical **Full Marks:** 50
Course No.: MET 323 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Practical **Year:** II

Course Objectives:

- The objective is to train the students in synoptic and aviation codes, and in computer application for meteorological purposes.

Study of surface observation from a land station, **9 hrs.**
Coding and Decoding of surface report from a station, **8 hrs.**
T-phi gram **8 hrs.**
Detailed study of aviation routine weather report and aviation selected special weather report coding and decoding of METER and SPECI. **6 hrs.**
Study of upper wind report from land station (PILOT), **6 hrs.**
Study of upper level pressure, temperature, humidity and wind report from a land station, **6 hrs.**
Plotting of TEMP and PILOT data, **6 hrs.**
Study of Terminal Aerdrome forecast (TAF) Code, **6 hrs.**
Analysis of surface and upper air plotted charts. **12 hrs.**

Introduction to Micro Computers: Hardware, input device; central processor, output devices; software; system software; application software. **3 hrs.**

Introduction to Disk Operation System (DOS): Resident commands; copy; dir; type; MD/CD/RD, external command; edit; xcopy; diskcopy; format; **3 hrs.**

Program Development for Meteorological Application: FORTRAN statement, flow chart, if --- else ----, do ------ continue------, read------ write format dim, data etc **14 hrs.**

Basic programming flow chart; command: rem; print; if …… else; for …… next; dim **10 hrs.**

Text Books:

1. Meteorological office, ***Handbook of Meteorological Instruments part II Instruments for Upper Air Observations***, Her Majesty's Stationary Office, England, 1961.

2. WMO No. 364, ***Compendium of Meteorology for Use by Class I & II Met Personnel Part III Synoptic Meteorology (Vol. I) –Vol. II Aernautical Meteorology***, World Meteorological Organization, Geneva, Switzerland, 1978.

Course Title: Hydrology **Full Marks:** 100
Course No.: MET 331 (Major/Minor) **Pass Marks:** 35
Nature of the Course: Theoretical **Year:** III

Course Objectives:

- Due to rapid growth in the world's population, the importance of water resources is increasing very rapidly. The course is designed to acquaint the students with the development of a nation with associated water resources linked with industrial production, generation of hydropower, irrigation and drinking purposes. The students will be able to estimate the maximum probable floods that may occur at a given site and its frequency for the safe design of reservoirs, drains, bridges and culverts. The maximum intensity of storm and its frequency are needed for the design of a drainage structures. Estimation of water yield from a basin, its occurrence, quantity and frequency and groundwater development, are all essential for hydrologic research.
- To adopt techniques in measurement of hydrological parameters both by classroom lectures and field experiments.
- To plan and manage reservoirs on the rivers for irrigation and power generation by having a qualitative and quantitative knowledge of the perennial rivers.

Introduction to Hydrology: Definition and scope, importance of hydrology, hydrologic cycle, history of hydrology, applications of hydrology. **2 hrs.**

Catchment Characteristics: Drainage shape, slope, altitude; hydrometric curve, stream length, catchment area; drainge pattern, density and stream order. **3 hrs.**

Precipitation: Forms and types, causes; reading and non-reading gauges, errors in measurement; site; average. depth calculation with different method; merits and demerits, network density; adjustment of missing data and interpretation, mass curve, hydrograph, depth area duration. **7 hrs.**

Infiltration: Factors affecting infiltration, measurement; infiltration equation and indices; capacity, infiltration process. **5 hrs.**

Water Losses: Classification of water loses, evaporation process, factors affecting evaporation, estimation, measurement, reduction of evaporation, interception, depression storage, transpiration and factors affecting transpiration. **6 hrs.**

Runoff: Sources of runoff, factors affecting runoff, computation of runoff; rainfall runoff correlation, runoff characteristics of streams. **5 hrs.**

Hydrographs: Components of hydrograph, and its separation; effective rainfall; unit hydrograph and theory; assumptions, use and limitation of Unit Hydrograph. **7 hrs.**

Ground Water: Definition, occurrence, type of acquifers, coefficient of transmissibility and permeability, Darcy's law and its rang validity and field measurement of permeability. **6 hrs.**

Hydrometry Basics and Applications: Definition and scope of hydormetry, history of hydrometry in Nepal and application of hydormetry in engineering field. **1 hrs.**

Stage Measurements: Site selection, measurement of stage, recording and non-recording gauges, water level recorder: float and pressure type; stage gauging with data logger system, crest gauge and its importance bench mark, vertical and inclined gauge, sectional gauge, flood mark. **7 hrs.**

Site Survey: Equipment, selection of site, longitudinal and cross section survey: leveling, layout plan preparation. **3 hrs.**

Velocity Measurement: Elementary hydraulics relating to discharge, velocity, slope, cross section area, roughness coefficient, site selection, equipment for velocity measurement; floats, current meter, calibration and maintenance of equipment, wading method, cable way measurement, errors, measurement in vertical sections; average velocity calculation. **7 hrs.**

Calculation of Discharge: Area velocity method, arithmetical and graphical methods, dilution method.

Indirect Method of Discharge Measurement: Field survey, slope area method, indirect method with structures and culverts. **4 hrs.**

Stage Discharge Relations: Various relations; stage discharge, controls; graphical plots, extrapolation and interpolation, estimating missing data. **4 hrs.**

Flow Measuring Structure: Uniform and non-uniform flow; wiers, rectangular, trapezoids and triangular, parshall flumes. **4 hrs.**

Sediment Discharge Measurement: Site selection, sampling instruments, measurement of suspended and bed load. **4 hrs.**

Water Quality: Analysis for major ions, water pollution, Instruments used, water quality requirements for industry domestic and agriculture. **3 hrs.**

Snow Hydrology: Introduction, snow and its classification, Distribution of snow, ripening of snow, properties of Snow. **3 hrs.**

Measurement of Snow, Precipitation Gauge: (a) standard and recording rain gauge (b) seasonal storage precipitation; Snow boards, snow stakes, snow pillow; determination of water equivalent of snow and instrument used. **7 hrs.**

Snow Survey: Snow course and snow survey; areal extent of snow cover; application of remote sensing. **7 hrs.**

Snow Melt and Sonwmelt Runoff Processes: Source of energy for snowmelt, (a) Radiation, (b) Sublimation, (c) Heat exchange; snowpack characteristics, (a) Metamorphism of snow and its type (b) Stratification of snowpack; site condition; rainfall; estimation of snowmelt. **10 hrs.**

Computation of Runoff form Snowmelt: (a) Seasonal water yield forecasting, (b) Runoff forecasting in river regulation, (c) Design flood due to snow. **7 hrs.**

Glacier Hydrology: Introduction; definition of the terms and sources of glaciers; glacier observations, glacier inventory; glacier classification, glacial level, snow line. Snow accumulation of glacier: (a) Snow observation and measurement technique, (b) Accumulation Zone-Determination of previous year's net Snow accumulation. (c) the glacier ablation zone. **10 hrs.**

Glacier Characteristics: Glacier mass balance and glacier variation; glacier movement, erosion and sediment production. **7 hrs.**

Glacier Lake and glacier lake Outburst Flood (FLOF): (a) Stability of glacier lakes and mechanism of outburst from glacier lakes, (b) Glacier lakes of Nepal, (c) Sedimentation in a glacier lake (d) Methods of presentation of GLOF. **7 hrs.**

Text Books:

1. Ven Te Chow, Chief Ed., : Hand Book of Applied Hydrology, McGraw Hill Book Co., New York.
2. M. Gunnel and M.J. Clark, : Glacio Fluvial Sediment Transport, John Wiley and Sons, New York.

Reference Books:

- Linsley et. al., : ***Applied Hydrology***, Tata McGraw Hill, New Delhi
- WMO Number 168 ***Guide to Hydrological Practicalities Vol. I***.
- Rantz et. al., : ***Measurement and Computation of Stream flow Vol. 2***, Paper 217; U.S. Govt. Printing Office, Washington D.C., 20402.
- Linsley et. al., ***Hydrology for Engineers***, McGraw Hill, New York, 1975.
- Eagleson, ***Dynamic Hydrology***, McGraw Hill Book Co., New York.
- Todd, ***Ground Water Hydrology***, John Wiley.
- Bruce and R.H. Clark, ***Introduction to Hydrometeorology***, Pregamen Press.
- S.I. Solomon and I. Cordery, ***Compendium of Meteorology***, NOC II Par 5 Hydrometeorology W.M.O. No. 346.
- John Store and W.P. Cross, E***lements of Applied Hydrology***, The Ronald Press Co., New York.
- Nemec, ***Engineering Hydrology***, Tata McGraw Hill, New Delhi.
- Corps of Engineers, ***Snow Hydrology***.
- W.S.B. Pterson, ***Physics of Glacier***, 2nd Ed., Pergamon Press, Oxford, N.Y., 1981.

Course Title: Tropical, Dynamical and Air Pollution Meteorology **Full Marks:** 100
Course No.: MET 332 (Major/Minor) **Pass Marks:** 35
Nature of the Course: Theoretical **Year:** III

Course Objectives:

- The weather in Tropics in different with that in mid latitudes. Therefore, the aim of tropical Meteorology is to familiarize the students about the Tropical weather, analysis and forecasting techniques.
- To provide fundamental knowledge of dynamical processes which determine the spatial and temporal distributions of meteorological variables (e.g. temperature, Pressure, Radiation & Water vapour), through the utilization of the equation of state, thermodynamic energy equation, hydrostatic equation, equations of motions and continuity equation. The theoretical knowledge will be further clarified by numerical problems –in each section.
- To provide knowledge of the effects of pollutants contaminating the atmosphere.

Tropical Meteorology:

Introduction to Tropical Meteorology: Introduction on Tropical Meteorology. **1 hrs.**

Primary Physical Controls of the Tropical Circulation: Earth's heat energy balance; tropical general circulation; primary physical factors-distribution of land and water, sea surface temperature, interacting with mid latitude systems. **3 hrs.**

The Observational Basis: Present date sources: surface data; upper air data-, oceanographic data, Meteorological satellite data, Radar data.
Probable Future Data Sources: Meteorological satellite data; Automatic Meteorological Stations; upper air observations from mobile ships, constant level balloons. **3 hrs.**

Pressure and Winds: Mean sea level pressure; diurnal pressure variations; Large scale pressure changes. **3 hrs.**

Winds: General; Resultant, gradient level wind; resultant 200 MB wind; mean wind cross sections; Jet streams; diurnal and local wind effects. **3 hrs.**

Temperature and Water Vapour: Surface temperature and water vapour, Mean diurnal variations, elevation effects. Upper air temperature and water vapour: seasonal changes; mean precipitable water; mean vertical soundings; diurnal variations; equivalent potential temperature. **6 hrs.**

Cloudiness: Cloudiness; mean cloud cover; Interannual cloud cover variations. Zonal cloud cover averages; Tropical cloud types; diurnal cloudiness variation. **1 hrs.**

Rainfall: Mean annual precipitation; annual rainfall variability; monthly rainfall variability; daily –rainfall distribution; rainfall variation with elevation; Meso- scale rainfall distribution; extreme rainfall amounts; rainfall associated with Tropical cyclones; beginning and ending of rainy seasons. **5 hrs.**

Tropical Synoptic Models: Waves:- easterly waves, equatorial waves, vortices:- low tropospheric cyclones, low tropospheric anticyclones, Mid-Tropospheric and upper tropospheric circulations. **5 hrs.**

Linear Disturbances: General; shear lines; clear air turbulence; asymptotes. **1 hrs.**

Tropical Cyclones: Classification and definition of Tropical Disturbances; Global climatology of Tropical cyclones, Tropical storms, their formation, movement and forecasting. Tropical storm characteristics: wind field, temperature field, cloud systems. **4 hrs.**

Severe Weather in the Tropics: Thunderstorms: frequency; diurnal variation; duration, tornadoes, hail, extreme winds, turbulence in lower and higher levels, icing General; climatological frequency, ocean wave phenomena, storm surges. **5 hrs.**

Dynamical: Introduction Meteorology:

Dynamical Meteorology: Introduction:

Introduction: Aim, atmospheric continuum, hypotheses, -units –and dimensions, dynamical operations, coordinate system.**5 hrs.**

Basic, Conservation Principle: Introduction, kinematics (velocity and acceleration), calculation of velocity and position from acceleration, kinematics of a totaling motion, velocity & acceleration (absolute and relative system), individual & local time derivates, fundamental & apparent forces, gravitational, Pressure gradient, frictional, centrigugal, coriolis forces, Equations of motion in cartesian, spherical and natural co-ordinates, scale analysis of equations of motion, numericals. **17 hrs.**

Other Basic Equations: continuity, thermodynamic and hydrostatic equations, numericals. **6 hrs.**

Application of Basic Equations: Basic equations in pressure co-ordinates, balanced flow, cyclostrophic, intertial flows, thermal wind, vertical motion, surface pressure – tendency, numericals. **12 hrs.**

Kinematics of the Wind: Circulation, vorticity, divergence, deformation, relation between circulation and vorticity, Kelvin's theorem, Bjerkness theorem, Principle of Solenoids, land and sea breezes, barotropic and baroclinic atmosphere. **10 hrs.**

General Circulation of the Atmosphere: Mean circulation in the troposphere, meridional circulation, jet streams. **6 hrs.**

Effect of Friction: Introduction to boundary layer Meteorology. **3 hrs.**

Air Pollution: Introduction: **1 hrs.**

The Atmospheric Boundary Layer: Solar radiation; terrestrial radiation, soil temperature; air stability; local wind structure; the logarithmic profile; the Ekman spiral; turbulence; statistical measures; boundary-layer scaling. **6 hrs.**

Pollutants and their Properties: Sources and emission of air pollutants; residence time and reaction rates; sulphur compounds; nitrogen and carbon compounds; organic compounds; acrosols and their properties. **7 hrs.**

Environmental Monitoring and Impact: Network design; meteorological monitoring; pollutant monitoring; pollutant effects on plants, human beings and materials, pollution indices. **7 hrs.**

Dispersion of Pollutants: Turbulent gradient transport, statistical theories of turbulent diffusion, Gaussian plume model and its applications. **4 hrs.**

Air Pollution Climatology: Spatial and transport variations of meteorological parameters including inversions, mixing depths, ventilation coefficient etc. **3 hrs.**

Text Books:

1. G.C. Asnani, : ***Tropical Meteorology Vol, I and II***, 822 Sindh Aundh, Pune, 1993.
2. Hess, : ***Introduction to Theoretical Meteorology***, Holt, Rinehart & Winston, New York, 1959.
3. Boubel Richard W. & Others, : ***Fundamentals or Air Pollution***, 3rd Ed., Academic Press, New York, 1994.

Reference Books:

1. Maj Gary D, : ***Forecaster's Guide to Tropical Meteorology***.
2. Herbert Reihl, : ***Tropical Meteorology***.
3. ***Compendium of Meteorology*** (Class I & II) Vol. II Part I ***Dynamical Meteorology*** (WMO No. 364)
4. J.R. Holton, : ***An Introduction to Dynamic Meteorology***, Academic Press Inc., New York.
5. Perkin, C. Henry, : ***Air Pollution***.
6. Davidson & Bryant, : ***Air Pollution Physical and Chemical Fundamentals***.
7. Tom Lysons & Bill Scott***, Principle of Air Pollution Meteorology***, CBS, New Delhi, 1990.
8. Ed. David H. Slade, : ***Meteorology and Atomic Energy***.
9. Stern, : ***Air Pollution***, (Ed.), Academic Press, New York.

Course Title: Hydrology and Surveying Practical

Full Marks: 100

Course No.: MET 333 (Major) **Pass Marks:** 35

Nature of the Course: Practical **Year:** II

Course Objectives:

- The students will be able to: analyze rainfall, depth area duration and plot them on given maps, graphically represent collected data, interpolate data for prediction, measure various parameters, survey using various techniques and instruments, use contour maps, apply remote sensing techniques to interpret land use, glaciers, land features, drainage systems. Cloudy patterns and types.

Surveys: Basics:- 1. River profile, 2. Cross section profile, 3. Velocity measurement by (i) float (ii) Currentmeter, 4. Discharge calculation **15 hrs.**

Rainfall Analysis

Practical Number 1: Double mass Curve analysis. **3 hrs.**

Practical Number 2: Isohectal and Thiessen polygon plotting on a map. **6 hrs.**

Practical Number 3: Calculation of mean precipitation depth by isohyetal, Thiessen and Arithmetic Mean Methods. **6 hrs.**

Practical Number 4: Depth area duration analysis. **6 hrs.**

Practical Number 5: Missing data interpretation. **6 hrs.**

Infiltration

Practical Number 4: Ring infiltrometer data analysis. **6 hrs.**

Runoff: Different methods of base flow separation, Unit hydrograph analysis with given data. **6 hrs.**

Statistical Analysis: Regression analysis, Optimization of number of rain gauges, Statistical analysis for recurrence interval (return period) of storm plotting method. **4 hrs.**

Hydrometry

discharge Calculation: Cross section profile with given data, cross section area with given data, measurement of velocity with correntmeter data, measurement of discharge, stage-discharge, velocity, Graphical and logarithmic extension, survey with given data, bearing and coordinates of location points. **6 hrs.**

Surveying **10 hrs.**

Practical Number 1: Fundamental concepts and principle of surveying.

Practical Number 2: Sources of error and types of errors for surveying.

Practical Number 3: Different methods of linear measurement chaining on uneven or sloping ground and errors in chaining, tape corrections.

Practical Number 4: Basic problems in chaining and plotting a chain survey.

Practical Number 5: Introduction of bearing and angles. The theory of magnetic compass.

Practical Number 6: Working operation of plane table surveying and errors in plane tabling.

Practical Number 7: Theodolite, use of a theodolote. Measurement of horizontal and vertical angles and source of errors in theodolite work.

Practical Number 8: Method of leveling, theory of direct leveling (spot leveling), errors in leveling.

Practical Number 9: Reduction of levels done by rise and fall and height of collimation method.

Practical Number 10: Use of contour maps, contour interval, characteristics of contours and interpolation of contours.

Remote Sensing Practicals: (a) Introduction to remote sensing and its importance, (b) Application of stereoscope to determine the land, features, (c) Identification of glacier area, (d) To delineate land use pattern (e) To delineate drainage system, (f) Study of cloud types with the help of instrument / Satellite images. **6×3 hrs.**

Text Books:

1. R. Varshey, : ***Engineering Hydrology***, Chand Printing Co., Roorkie.
2. Thomas M. Lillesand and Raiph W. Kiefer, : ***Remote Sensing and Image Interpretation***, John Wiley and Sons Inc.

Reference Books:

1. J. Nemec, : ***Engineering Hydrology***, McGraw Hill, New Delhi.
2. Lineley et. al., : ***Applied Hydrology***, Tata McGraw Hill.