

Subjects Taught:

- Observation Systems
- Dynamic Meteorology
- Numerical Weather Prediction
- Physical Meteorology and Marine Meteorology
- Synoptic Meteorology
- Aviation Meteorology
- Climatology and Statistics
- Satellite Meteorology
- Radar Meteorology
- Agricultural Meteorology
- Upper Air Instrumentation
- Surface Instruments
- Meteorological Telecommunication and Information Technology
- Environment Monitoring
- Seismology
- Positional Astronomy
- General Administration
- Data Base Management



India Meteorological Department

Syllabus **For** **Integrated Meteorological Training** **Course** **For Direct recruited SAs** **(4 Months duration)**

2019

Total duration = 17 working weeks
Number of working days in one working week = 5
Total number of working days= 5 x 17= 85
Joining & induction= 1 day
Relieving = 1day
Final Exam = 9 days (6 Theory & 3 practical)
Viva voce = 1day
Expected Gazetted Holidays = 8 Days
Number of working days available for training = 85-20=65 days
Number of periods in one working day: 3 periods each of 75 minutes duration in Forenoon and 3 periods each of 75 minutes duration in the Afternoon
- Total 6 periods in a day
Total number of periods available for training = 65 x 6 = 390
Periods of teaching for each subject

S.No.	Disciplines / Subject	Periods
I.	Observational systems	55
II.	Dynamic Meteorology	22
III.	NWP	10
IV.	Physical Meteorology & Marine Meteorology	30
V.	Synoptic Meteorology	45
VI.	Aviation Meteorology	35
VII.	Climatology & Statistics	43
VIII.	Satellite Meteorology	10
IX.	Radar Meteorology	10
X.	Agricultural Meteorology	10
XI.	Upper Air Instrumentation	10
XII.	Surface Instruments	30
XIII.	Meteorological Telecommunication & Information Technology	12
XIV.	Environment Monitoring	10
XV.	Seismology	10
XVI.	Positional Astronomy	02
XVII.	General Administration	24
XVIII.	Data Base Management	02
XIX.	Visit to scientific / technical units	20
	Total	390

I. Observational Systems (55 Periods)

- General principles of observations: representativeness of observations, Metadata of observatories, general requirement of a meteorological observatory, siting and exposure (Surface Observatory – description and arrangement of various instruments), measurement standards and definitions, uncertainty of measurements, Operational measurement accuracy requirements and instrument performance. (5 Periods)

Surface Observations (20 Periods) [10 theory + 10 Practical]

- Introduction; Meteorological elements; Atmospheric Pressure and its measurement; Barometer – Fortin and Kew Pattern, description, reading, correction, reducing the value to mean sea level, exposure; Aneroid/precision barometer, digital barometer.
- Thermometer: Dry Bulb, Wet Bulb, maximum and minimum – description, method of working, reading and resetting; Stevenson screen, digital thermometer, exposure, precautions/guidelines for instruments maintenance.
- Humidity – Definition, calculation of relative humidity from dry and wet bulb readings; Dew point temperature; Description and working of Assman and Whirling psychrometer, digital hygrometer.
- Wind instruments – Definition of wind, units, Beaufort scale; Wind vane and anemometer, Dines PT anemograph, electrical anemograph, HWSR, description and working principle.
- Rain gauge: - Description and working, measurement of rain using different rain gauges.
- Snow Gauge: - Description and working measurement of snow fall using different snow gauges.
- Clouds classification types, description, amount, height of base and direction of movement
- Visibility: - Definition, visibility land marks, night visibility
- Present weather: Description, definition of various weather phenomena
(Including special weather reporting), symbolic representation and past weather.
- Recording of surface observations (both Land/ship) - pocket register; Monthly Meteorological register, weather diary, Ship Log, observational data digitization.
- Self-recording instruments – description and working of barograph, thermograph, hygrograph, self-recording rain gauge, Dines P. T. anemograph, and Sunshine recorder. Tabulation and analysis of barograph, anemograph and thermograph
- ARG, AWS, Aviation Met Instrument including transmissometer & applications, Agrometeorological and radiation instruments.
- Instruments for environment monitoring and air quality, Ozone and Greenhouse gases measurements.
- Emerging trend in Meteorological observations (Airborne / Shipborne etc.)

Upper Air Observations (15 Periods = 5 theory + 10 practical)

- Instruments and accessories used in pilot balloon work; Method of calculating upper wind's; Description of theodolite, prismatic compass, datum point, azimuth and elevation angles, graticule reading; Free lift tables; Filling the balloon; P. B. ascent without tail, following the balloon and taking readings; Computation of upper winds; P. B. ascent with tail, graticule reading, and derivation of the formula for calculating the height, drawing the trajectory and computation of winds; P B ascent at night; Upper wind registers.
- Principles of measurement of upper air temperature, pressure and humidity by Meteorograph and Radio sondes; Principle of measuring winds by Radar and Radio theodolite method; (elementary ideas only)
- Preventive maintenance of Met Instruments.
- **Codes: (15 Periods)**
Meta data, Introduction, Surface (synoptic & asynoptic) (land & sea) codes, upper air codes, Temp code, exercises in coding and decoding. CDES and MMR online.

II. Dynamic Meteorology (22 Periods)

- **Equation of Motion:** Frames of reference: inertial & non-inertial frames; Vector equations of motion (No derivation). Local tangential coordinate system. Equation of motion (in component form), explanation (without derivation) of all the terms. Pressure as a vertical coordinate & its usefulness. Horizontal equation of motion with pressure as a vertical coordinate. Atmospheric forces: Real & apparent forces, body & surface forces: Coriolis force, Pressure gradient force, Centrifugal force, Gravity and Gravitational force. (2 P)
- **Geostrophic approximation:** Definition and properties of geostrophic wind. Vectorial expression for geostrophic wind. Schematic diagram to show how geostrophic balance can be achieved. Ageostrophic wind: Definition, vectorial expression and its property. (2 P)
- **Hydrostatic approximation:** Hydrostatic equation. What is hydrostatic approximation? Discussion on the validity of this approximation. Using above approximation, definition of atmospheric pressure at any point. Definition of geopotential and geopotential height of a point and corresponding units. Hypsometric equation (no derivation) and its use in computing thickness of a layer of atmosphere (2 P)
- **Balanced flow:** Introduction to natural coordinate system. Horizontal equation of motion in natural coordinates. Gradient balance and gradient wind. Physically possible different gradient flows.

Special cases of gradient balance: - geostrophic balance, inertial balance, and cyclostrophic balance.
Examples. (2 P)

- **Vertical variation of wind:** Concept of vertical wind shear. Schematic explanation for horizontal temperature gradient leading to vertical shear of geostrophic wind. Thermal wind: Definition, Thermal wind equation (No derivation) and properties of thermal wind. Application of the concept of thermal wind: cold and warm advection associated with veering/backing of geostrophic wind, Jet stream, cold/warm core lows/high. Concept of barotropic and baroclinic atmosphere. (2 P)
- **Kinematics of wind and pressure field:** Definition of Streamlines and trajectory, relation between them, streamline patterns for pure translations, pure divergence, pure rotations and deformations. Definition and mathematical expression for center of Lows/ highs, equation for trough/ ridge and Col. (2 P)
- **Conservation of mass:** Equation of continuity, Dines compensation principle, Concept of the level of non-divergence. Moisture continuity equation. (2 P)
- **Divergence & vorticity:** Definition of Divergence and vorticity & their mathematical expression. Illustration by typical cases on synoptic charts. (2 P)
- **Introduction to PBL:** Definition of PBL, Importance of PBL, Convective turbulence & mechanical turbulence, depth of PBL, Static stability, Richardson number. Different sub layers in PBL. (2 P)
- **Practical for Dynamic Met.:** Computation of horizontal divergence & vorticity at a point on the streamline using curvature method. Computation of the above and vertical velocity using finite difference grid, Computation of geostrophic wind, thermal wind. (4 P)

III. Numerical weather prediction (5+5=10 Periods)

Theory (5 Periods)

- Operational NWP modelling system: Global Forecast System, Regional and mesoscale forecast system (WRF, ARPS, GFS, GEFS, CFS).
- NWP Products & their interpretation: Different products: Direct and Derived, Post processing of model output: NWP products for: aviation services, cyclone forecasting & warning, monsoon rainfall system, localized severe weather, Western disturbances., NWP products in Web.

Practical (5 Periods)

- Basics of Linux O.S, Model diagnosis: Graphics package for illustration of NWP products, Case study of monsoon depression, cyclonic storm etc.
- Experiments with nowcasting tool

IV. Physical Meteorology & Marine Meteorology (30 Periods)

Theory (22 Periods)

- Chemical composition of air, green house and trace gases and their importance.
- Vertical structure of atmosphere, Concept of lapse rates (DALR, SALR, ALR). Laws of thermodynamics, concept of potential temperature, relation between potential temperature and entropy.
- Moisture in the atmosphere – partial pressure of a constituent gas in a mixture of gasses, equation of state for a mixture of gasses, vapor pressure, saturation vapor pressure, relative humidity, mixing ratio, virtual temperature, dew point and wet bulb temperatures, Changes in saturation vapor pressure with temperature, Moist adiabatic lapse rate, Equivalent potential temperature.
- Geopotential, pressure-height curve, Thermodynamic diagram, use of Tephigram, Statement of Normand's theorem, Computation of derived moisture variable and the height of pressure surface using Tephigram.
- Concept of static stability, Parcel Method.
- Cloud physics: Fog, clouds and precipitation, basic knowledge of their formation
- Importance of radiation in the study of meteorology, Spectrum of electromagnetic radiation, Concept of black body radiation, emission and absorption of radiation, concept of solar constant and albedo, Laws of radiation, units. Basic concepts Scattering, Rayleigh and Mie scattering, Radiative transfer and Beer's law, concept of optical depth. Terrestrial and solar radiation, Annual mean global energy balance for earth –atmosphere system.
- Marine Meteorology: Basic measurements of meteorological/ oceanographic parameters. Importance of observations from Sea. Collection of marine data from Ship's log and their compilation. Importance of oceans in the atmospheric processes, and their role in weather/climate. Observations from oceans (in situ) and their procedural aspects; VOF. Surface meteorological and upper air observations on board ships, collection, exchange and archival. Ships Weather log. PMO/data collection.

Practical (8 Periods)

- Analysis of Radiosonde data using T- Φ diagram: Calculation of virtual temperature. Calculation of pressure height curve.
- Plotting of the sounding data Dry bulb, wet bulb and Dew point temperature. Graphical determination of LCL, CCL and level of free convection. Demarcation of positive and negative areas.
- Instability indices and calculation using T- Φ diagram

V. SYNOPTIC METEOROLOGY (45 Periods)

Theory (25 Periods)

- Scales of weather systems; Network of Observatories; Surface, upper air; special observations (satellite, radar, aircraft etc.); analysis of fields of meteorological elements on synoptic charts; Vertical time / cross sections and their analysis. (2 P)
- Wind and pressure analysis: Isobars on level surface and contours on constant pressure surface. Isotherms, thickness field; slope of pressure system, streamline and isotach analysis. (2 P)
- Thunderstorm and severe local storm, synoptic conditions favorable for thunderstorm, concepts of triggering mechanism, conditional instability; Nor'easters, dust storm, hail storm. Squall, tornado, microburst/cloudburst, landslide. (3 P)
- Indian summer monsoon; S.W. Monsoon onset: semi-permanent systems, Active and break monsoon, Monsoon depressions: MTC; Offshore troughs/vortices. Influence of extra tropical troughs and typhoons in northwest Pacific; withdrawal of S.W. Monsoon, Northeast monsoon, (4 P)
- Easterly wave and its structure and associated weather. Tropical Cyclone: Life cycle, vertical and horizontal structure of TC, Its movement and intensification. Weather associated with TC. (3 P)
- Waves in mid-latitude westerlies, Western disturbance and its structure and associated weather (2 P)
- Jet Streams – WMO definition of Jet stream, different jet streams around the globe, Jet streams and weather (2 P)
- Meso-scale meteorology, sea and land breezes, mountain/valley winds, mountain wave. (1 P)
- Short range weather forecasting (Elementary ideas only); persistence, climatology and steering methods, movement and development of synoptic scale systems; Analogue techniques- prediction of individual weather elements, visibility, surface and upper level winds, convective phenomena. (2 P)
- Some basic concepts in impact-based forecast and warning services: Basic concepts of Hazards, forecast uncertainty, exposure, Vulnerability, risk and Risk matrix. Basic concepts of the different Paradigms in operational Weather services: Weather forecast & Warning, Impact based forecast & warning and Impact forecast & warning. (4 P)

Practical (20 Periods)

- Decoding and plotting of surface and upper air data.

- Techniques of analysis. Climatological charts. Surface charts. Upper wind charts. Constant pressure charts.
- Analysis of surface chart including auxiliary charts.
- Kinematic (streamline and isotach) analysis of wind charts.
- Analysis of constant pressure charts.
- Analysis of surface and upper air charts of monsoon depression.
- Analysis of surface and upper air charts of Cyclonic Storm (Tropical Cyclone)
- Analysis of surface and upper air charts with western disturbance.
- Analysis of Jet streams and waves in upper tropospheric westerlies
- Synergie Familiarization.

VI. AVIATION METEOROLOGY (35 Periods)

TOPIC	Sub topic	Objective: On completion the trainees should be able to:	No. of Periods
An overview of Aviation Organizations and their functioning.	1. WMO, ICAO, CaeM	List the mandate of the organizations	3
	2. Components of ATM	Understand the functioning of ATC, Communication & Met and their inter-dependability. Understand concept of FIR, FIC, AIP	
	3. Functioning of IMD's Aeronautical Met Organizations	Understand the functioning of MWO, AMO and AMS Role and responsibilities of Met Watch Officer, Duty Officer, CW Assistant Documents and procedures to be maintained.	
	4. Provisions of CAR & PANS-Met	Understand basics provisions and their own role and responsibilities as AMP.	
Effect of Weather on aviation	1. Effect of various atmospheric parameters on different phases of flight operation	Understand the effect of weather elements on aircraft operation	1

	2. Weather hazards to aviation	List the weather hazards and Understand its effect on aircraft operation	1
	3. Climatology of Aerodrome	Understand broad features of climatology of hazardous weather for each FIR Generate and interpret climatological information from CW data and other available sources.	1
Observation and reporting of weather for Aviation services (METAR/SPECI)	1. METAR/ SPECI code	1. Understand the latest METAR/ SPECI code form and SPECI criteria 2. Prepare a METAR/ SPECI message using the given observations 3. Understand the basic concepts of TREND forecast	2
	2. SPECI Criteria		
	3. Reporting of meteorological elements in METAR/ SPECI		1
	4. Basic concepts of TREND forecast		1
	5. Prepare a METAR/ SPECI message using the given observations		1
Observation and reporting of weather for Aviation services MET Report/ SPECIAL	1. MET Report/ SPECIAL Report Template	1. Understand the latest MET Report/ SPECIAL Report template 2. Prepare a MET REPORT/ SPECIAL message using the given observations	2
	2. Difference in reporting of elements in METAR and MET Report		1
	3.Examples of preparation of MET REPORT/ SPECIAL		1
TAF/Area forecast	1. Description of the TAF code form	1. Understand TAF code	2
	2. Decoding of the coded TAF into plain language message	2. Decode a coded TAF into a plain language message	1
ROFOR	1. ROFOR Code	1. Describe ROFOR code	3

	2. Decoding of the coded ROFOR in plain language	2. Decode a ROFOR and prepare the route forecast in MET-T3/ MET- T4 format	
	3. Instructions on preparation of MET		
	4. Instructions on preparation of MET		
	5. Preparation of a route forecast in MET		
	6. Preparation of a route forecast in MET		
Reporting & dissemination of SIGMET,	1. Template for SIGMET	1. Understand the SIGMET template 2. Understand an actual SIGMET 3. Rx/Tx and station included in India.	1
	2. Elements of SIGMET		
	3. Its Rx and Tx		
Aerodrome warning, Warning for light aircrafts Wind shear warnings	1. Responsibility of AMO and AMS	1. Understand the responsibilities of AMO and AMS in relation to issuance of warnings 2. List the warning elements 3. Understand the format of the warnings and Understand given a warning	1
	2. Warning elements		
	3. Warning format		1
TCAC and VAAC advisories	1. Responsibility of TCAC and VAAC	1. List the responsibilities of TCAC and VAAC 2. Understand the templates of TCAC advisory and VAAC advisory Understand given advisories.	1
	2. Template of TCAC advisory with example		
	3. Template of VAAC Advisory with example		1
WAFS products	1.Type of WAFS charts available	1. List the WAFS products available 2. Describe a given WAFS SIGWX chart and SIGWX chart. 3. Sources and procedure for receiving the WAFS products	2
	2. Chart specifications		
	3. Contents of charts		
	4. Description of SIGWX elements depicted		

	5. Interpretation of national and WAFC SIGWX charts		
Briefing and documentation	1. List of documents to be provided	1. List the items to be provided in documentation	1
	2. List of items to be displayed in met offices	2. List the items to be displayed in an aviation met office	
	3. Briefing of low level flights	3. Understand the special requirements of low-level flights	
	4. OLBS-products available and its updation schedules and methods	4. To download the products from OLBS or other sources.	1
ATN (Aeronautical Telecommunication Network)	1. Basics about aeronautical telecommunication network	1. Understand the aviation telecommunication network	1
	2. Filing time, transmission time and priority of various aviation meteorological messages	2. filing time and transmission time of aviation met messages	
	3. Basic concept of ROBEX scheme	3. Understand ROBEX scheme	1
	4. Basics of VOLMET broadcast	4. Understand VOLMET	
Accident Investigation	1. Introduction	1. Understand the procedures to be followed by various offices	1
	2. Responsibilities of a Met observer		
	3. Responsibilities of an Aviation met office		
	4. Preparation of Reports		

VIP/VVIP movement	1. Basic procedure to be followed during VIP/VVIP Flights	1. Understand the procedures to be followed by various offices	1
Airport Meteorological Instruments	1. Basic functions and use of airport meteorological system	1. List and Describe the components of airport met instruments system 2. Read AMIs and report	1
Total classes			35

VII. Climatology & Statistics (43 Periods)

Climatology (23 Periods)

- Earth Sun relationship. Ecliptic and equatorial plane, Rotation and revolution of the earth Equinoxes, Solstices, Perihelion and Aphelion, Causes of seasons, Seasonal and latitudinal variation of insolation. (1 Period)
- Weather, climate, Elements of weather, climate controls, weather phenomena, Semi-diurnal variation of pressure, Diurnal variation of temperature. (2 Period)
- General circulation of the atmosphere over the globe. Pressure and wind belts. Distribution of pressure and temperature over the surface of the earth, Equatorial trough & Inter tropical convergence zone (ITCZ). (2 Period)
- Climatic Classifications of climate (2 Period)
- Indian Climatology – Four Seasons (2 Period)
- Winter season – Western disturbance and Easterly waves and weather associated with them. Fog, cold wave, Thunderstorm and Hail Sub-tropical westerly Jet stream. (3 Period)
- Pre monsoon season – Heat wave, Cyclonic storms in the Indian seas, Western disturbances with associated induced lows. Factors affecting visibility in India – fog, dust storm, dust raising winds, Thunderstorms, hailstorms, Nor-wasters. (3 Period)
- Southwest monsoon season – Onset and advance of southwest monsoon Semi permanent systems of monsoon, Strong and weak monsoon, break monsoon, Factors affecting distribution of monsoon rainfall. Synoptic systems in monsoon particularly monsoon depression Inter-annual and intra-seasonal variability of monsoon. (3 Period)

- Post Monsoon season: Withdrawal of southwest monsoon and northeast monsoon, Cyclonic storms in the Indian seas, Western disturbances, easterly waves. (3 Period)
- Climate change and Global warming. Basics of Climate Change. Observed climate change over India and globe. Definition of Global warming, its possible causes and its impact on environment. (2 Period)

Section- B:
Statistics (20 Periods)

Theory (12 Periods)

- **Introduction:** Definition of statistics, usage, Statistics as applied to Meteorology, analysis of climate data, studies on climatic change, statistics in weather forecasting, in forecast verification, study of relation amongst variables, some limitations of statistics. (1 Period)
- **Frequency distribution:** Variables continuous and discontinuous, frequency distribution, frequency functions, diagrammatic representation, histograms, frequency curves and ogives. (1 Period)
- **Measures of Central tendency or averages:** Definition, requisites of good average, computation of arithmetic mean, median & mode, graphical determination of median and mode, merits and demerits of each, use of averages in meteorology. (1Period)
- **Measures of dispersion / variation:** Definition, various measures, range, quartile- mean- standard deviations, co-efficient variation, usage in meteorology especially in rainfall, introduction of skewness, kurtosis. (1Period)
- **Correlation analysis:** Definition, examples, scatter diagram, Pearson's co-efficient of correlation, merits and demerits, correlation analysis in meteorology, non-linear relation. (2 Period)
- **Regression analysis:** Definition, regression lines of x on y and y on x , standard error of estimate, merits and demerits, forecasting based on regression equation. (2 Periods)
- **Probability theory and theoretical distributions:** Definition of probability, additive and multiplicative laws, Binomial, Poisson and Normal distributions, their applications in meteorology. (2 Periods)
- **Sampling:** Concept of sampling, random sampling, level of significance, standard error, testing of significance of sample mean and testing of significance of difference between two sample means (both large and small samples), Student's t -distribution, testing the significance of correlation co-efficient. (2 Period)

Practical (8 Periods)

- Computation of mean, mode, median, standard deviation and coefficient of variation, Computation of skewness and kurtosis. Computation of probability. (3 Periods)
- Computation of correlation coefficient, construction of regression lines and computation of regression coefficients. (2 Periods)
- Test of significance for mean, testing of significance of difference between two sample means, test of significance for standard deviation and correlation coefficient. (3 Periods)

VIII. Basics of Satellite Meteorology (10 Periods)

- Principles of remote sensing, Introduction to basic principles of satellite meteorology, Meteorological satellites, Polar orbiting and geostationary satellites, Current and future meteorological satellites of the world, Payloads on Meteorological satellites, INSAT, Kalpana, Meteosat, GOES, Himawari, FY, Megha-Tropiques, SCATSAT-1, NOAA NPP /JPPS, Metop etc. (2 Periods)
- Details features of Real Time Analysis of Product & Information Dissemination (RAPID) web-based tools for satellite Data/products visualization (4 Periods)
- Interpretation of Satellite Images: Characteristics of various channels, Identification of typical clouds and weather systems from cloud imageries, Satellite bulletin and its interpretation. Tropical cyclones, their identification and grading using Dvorak's technique. Introduction to images and RGB & derived products of various international satellites. (4 Periods)

IX. Basics of Weather Radars and Radar Meteorology (10 Periods)

- Introduction to Weather radars. Different frequency bands used in the weather radars and their applications. Principles of pulsed radar, Polarimetric radars.
- Limitations and artifacts of Weather Radar, Common misconception/errors in radar products/data.
- Definitions of Beam width, Pulse width, PRF, Antenna gain, back scattering cross section, Reflectivity factor (η) and radar reflectivity factor (Z) and its relevance to weather radar equation. Doppler Dilemma, probable resolving measures.
- Concept of dB, dBZ, dBm, dBW and inter-conversions and to liner terms.
- Principle of Doppler Weather radar. Block diagram of Doppler Weather radar and explanation of its major components.

- Common Scan Strategy of IMD and its need.
- Introduction to DWR Base products (PPI, CAPPI, PCAPPI, MAX, VCUT, LAYER, EBASE & ETOP)
- Derived DWR products – their interpretation and use in Nowcasting Hydrological Products (SRI, PAC, VIL, PRT, Catchment)
- Wind products (VAD, VVP, Shear, Turbulence, Gust Front)
- Warning products (Severe Weather Index, Hail warning, Tornadic Vortex Signature)
- Forecast Products (FCST, Track)
- Application of DWR data in NWP for nowcasting and forecasting. Introduction to Some models like SWIRLS, WDSSII, ARPS, DELHI PP etc.
- Interpretation of radar observations, Case Studies / Examples of recorded events of severe weather events (Thunderstorms, Hail, MCC, Squall, Cyclones etc.)

X. Agricultural Meteorology (10 Periods)

- **Concept of Agricultural meteorology:** Introduction to Agro meteorology, Scope and importance of agro meteorology, Familiarization with important activities of Agrimet Division, general concepts of radiation in relation to agriculture, photosynthetically active radiation, saturation light intensity and efficiency of light utilization, Weather and climate effects on crop growth and development, Weather, climate and livestock.
- **Agromet observatory/Agromet observations:** Agromet instruments and their installation, Maintenance, Inspection of observatories, Time of observations, use and archival, methods of taking observations in experimental crop field for agrometeorological field research.
- **Agro climatic Zones:** General concept, criteria for climatic classification, climatic classification in India Objectives, Agro climatic classifications and their applications, Rainfall analysis, drought studies including drought monitoring, Evaporation, Evapotranspiration, Dry land farming, Pest & Disease etc.
- **Agromet advisory services (AAS):** Importance of Agromet advisory services to farmers, Development from AAS to IAAS, Components of AAS bulletins, Preparation of special weather charts and bulletins for AAS, use of research data for operational work, Dissemination, Feedback collection –participatory approach and engaging with farmers.

- **Field visit exposure with Agro climatic observations/ Practical on preparation of State Composite Bulletins**

XI. Upper Air Instrumentation (10 Periods)

Basics of instrumentation: (4 Periods)

- Basic principles of instrumentation – sensors and their desired qualities, signal conditioning, linearity response, calibration of instruments.
- Decimal and binary system of counting, decimal to binary and binary to decimal conversion. Logic gates OR, AND, NOT, NAND, NOR, XOR (EXCLUSIVE – OR) and Buffer circuits.
- Overview of General Antenna theory – Micro-wave and Radar antennae – Gain of antenna in decibels. Movable antennae. Role of Servos in Antenna movement.

Introduction to Radiosonde/ Radio wind Systems. (UAL) (6 Periods)

- Principle of Radiosonde, Sensors used in Radiosonde and their principle of operation, Accuracy requirements for the measurement of various parameters i.e. Pressure, Temperature & Humidity. Sources of error, radiation exposure, ventilation.
- RS/RW observation: Introduction, Theory of GPS system, methods of tracking balloon and wind data derivation. Computational algorithms and procedures. Basic equations and algorithms, sources of errors and TEMP code.
- Introduction to Wind profiler, Lidar and Microwave radiometer. basic working principle and application.
- Meteorological Balloons- Types of balloons used for RS ascents, Filling & Launching.
- Hydrogen gas, water activated Batteries and Method of preparation of hydrogen gas. Global climatological observing System (GCOS System)

XII. Surface Instruments (30 Periods)

Surface Laboratory: (08 Periods)

During the periods (Theory + Practical), emphasis would be laid on operation, maintenance, care to be taken in handling, trouble shooting and rectification.

A list of instruments that will be briefly covered under this training course are given below:

S. No.	Met element	Reading instruments	Recording instruments
1.	Temperature	DB, WB, Max., Min. thermometers/ Thermometer screen	Bimetallic Thermograph
2.	Relative Humidity	DB-WB Thermometer, Psychrometer (Whirling and Assmann types)	Hair Hygrograph
3.	Precipitation	Non Recording Rain gauges, Rain Measures, different types of Clock Drums (Mechanical/ Quartz type)	Self Recording Raingauges, Tipping Bucket Raingauges
4.	Surface wind	Cup Counter Anemometer, Mechanical wind vane, Portable wind vane. Methods of installation of wind instruments with respect to True North etc. Sensitivity of Anemometer.	Brief discussion on DPTA, Identification and rectification of defects in DPTA.
5.	Atmospheric Pressure	Mercury Barometers, Aneroid Barometers, Precision Aneroid Barometers, Comparison of mercury barometers	Microbarograph
6.	Duration of sunshine		Campbell Stoke's Sunshine Recorder
7.	Solar Radiation	Brief discussion on Pyrheliometer, Pyranometer	---
8.	Evaporation	Open Pan Evaporimeter	---
9.	Familiarization with the Inspection Kit box items and its usage in the field, non-instrumental observations (viz. visibility, cloud).		
10.	Inspection of surface meteorological observatories.		
11.	Calibration of equipments and methods of calculation of Met. Parameters.		

Automatic Weather Station/Automatic Rain Gauge (Theory + Practical): 10 Periods

- **AUTOMATIC WEATHER STATIONS/AUTOMATIC RAINGAUGE STATION:**

Introduction, purpose of establishing an aws network, basic concept of telemetry, satellite communication, earth and space segments, types of AWS system, overall concept of AWS, installation of AWS, testing and maintenance.

- **SENSORS AND THEIR CHARACTERISTICS: (accuracy, resolution and linearity)**

Types of sensors, analog, digital, serial, SDI-12 sensors, different outputs of sensors, basic principle of measurement of atmospheric pressure sensor, air temperature, relative humidity, wind speed, wind direction, rainfall, duration of sunshine, soil moisture, soil temperature, leaf temperature, leaf wetness etc. interfacing of different sensors with the logger, signal conditioning for different sensors.

- **DATA LOGGER AND TRANSMITTER:**

Components of data logger and transmitter, configuration and operation of data logger and transmitter, different types of data loggers and transmitters in use (Sutron, Astra and Jinyang make), troubleshooting procedures for data logger and transmitter, interfacing of sensors with data logger, scheduling the sampling of meteorological parameters, configuration of data logger and transmitter through laptop using communication software.

- **POWER SUPPLY:**

Power requirements, use of battery and solar panel, calculation of power budget for a particular configuration, testing, installation and maintenance, usage of switched power to sensors for saving power

- **AWS DATA FORMAT:**

Study of 422-bit data format, generation of identification code (bch code), encoding and decoding of 422 bits, mode of aws data transmission. pseudo random burst sequence(PRBS) and time division multiple access(TDMA) techniques of data transmission

- **DISPLAY:**

Interfacing of display with Sutron, Astra and Jinyang data logger

- **PCMCIA CARD/FLASH CARD/PEN DRIVE:**

Retrieval of aws data from the field unit, reading and writing of aws files (setup files, data files, log files etc.) from the system to the card. downloading of data files onto the computer for further processing.

- **ANTENNA/GPS ANTENNA:**

Types of antenna (crossed Yagi antenna for Tx, parabolic dish antenna for Rx), installation and testing, theory of polarization – RHCP/LHCP, orientation of antenna. GPS antenna, understanding the utility of GPS for time synchronization, exposure conditions for antenna.

- **RECEIVING EARTH STATION:**

PRBS and TDMA earth stations, components of receiving earth station - low noise amplifier, down converter, digital readout ground station, processing server, X-connect software for decoding PRBS aws data, Astra data inject/ raw decoder software for decoding TDMA aws data and maintenance of aws database, coding of aws data in WMO format and transfer of coded data to AMSS and to GTS.

- **SATELLITE LINK CALCULATION:**

Calculation of uplink(c/no) and downlink (c/no), EIRP, free space losses, quality objectives of the satellite link.

- **MAINTENANCE OF AWS SYSTEM:**

Preventive and corrective maintenance of aws system/ sensors. Field calibration, protection of system/sensors in harsh environments, use of NEMA-iv enclosures and prevention of moisture ingress into the system.

- **GUIDELINES FOR SELECTION OF SITE FOR AN AWS/ARG.**

- **GUIDELINES FOR CONSTRUCTION OF CIVIL STRUCTURES AT THE SITE.**

- **Practical:**

- 1) Sensors interfacing with data loggers
- 2) Antenna installation and establishing satellite link
- 3) Preventive Maintenance
- 4) Fault finding procedures
- 5) Data checking & validation.

6) Field Calibration

Personal and equipment safety

AIRPORT METEOROLOGICAL INSTRUMENT

8 Periods

- **Measurement of Wind and Temperature:** Sensors for wind and temperature measurements; Calibration of sensors; Wind tunnel; temperature bath; temperature chamber; Analog CWIS - signal conditioning circuits for wind and temperature sensors, strip chart recorders, disadvantages of analog systems; analog DIWE; ICAO recommendations for digital systems; microprocessors; data acquisition systems; advantages of data loggers over strip chart recorders; digital CWIS - use of sensors like sonic wind vane, hygroclip in digital systems, advantages of digital systems over analog systems, installation and field calibration of CWIS and its periodic maintenance; Pressure measurement - QFE, QNH.
- **Measurement of Visibility:** ICAO definitions; Met. visibility by day and by night; Runway visual range; definitions related to RVR measurement; Allard's Law and Koschmieder's Law; Measurement of RVR; disadvantages of manual measurement of RVR; advantages of instrumental measurement of RVR; Transmissometers - Forward scatter meters, Selection of proper baseline length, single and dual baseline length Transmissometers, calibration of Transmissometers, advantages of dual baseline Transmissometers.
- **Measurement of Cloud Base Height:** Methods of cloud height measurement, Ceilometers Laser Ceilometers, working principle, operation and maintenance of Laser Ceilometers; Advantages and disadvantages of Laser Ceilometers.
- **Integrated Aviation Met. Systems:** Basic principle; integration of digital CWIS; Transmissometers and Laser Ceilometers; block diagrams, cable modems, radio modems, testing of cables; advantages.
- **SITING of AVIATION instruments:** Differences between a synoptic and aerodrome observatory; selection of runway site for aviation meteorological instruments; location of instruments for surface wind, temperature, runway visual range, pressure and cloud base height. ICAO standard
- **Practical:**
 - 1) Sensors interfacing with data loggers
 - 2) Communication link for transmitting data from runway to ATC
 - 3) Preventive Maintenance
 - 4) Fault finding procedures
 - 5) Data checking & corrective actions.
 - 6) Field calibration

RADIATION INSTRUMENTS

4 Periods

- General requirement of Radiation instruments, measurement of sunshine, and intensities of solar radiation.
- General principles of radiation measuring instruments and methods of observation.
- Pyranometers, Pyrheliometers etc.
- Measurement of direct, global, diffuse and reflected solar radiation.
- Thermoelectric Pyrageometer for net terrestrial radiation (Continuous measurements) and Net pyradiometer for total net radiation.
- Measurement of UV radiations with UV radiometers.
- Operation of microcomputer controlled Sun tracker.
- Familiarization with uses of UV/NIR/Vis range Spectrophotometer.
- Operation and maintenance of data loggers for radiation measurements. Calibration, Maintenance and rectification of defects of Radiation instruments.

XIII. Meteorological Telecommunication and Information Technology (12 Periods)

- Concept of communication of HF, VHF, UHF and Microwave, GSM and GPRS, internet communication (1 Periods)
- Introduction to Met. Communication Systems (VSAT, IVRS, AMSS, CIPS and Synergie) (2 Periods)
- GTS WMO Procedure & Protocols: - WIS, GISC, DCPC, NC, Meta data, WMO Headers and Data Routing procedures, BUFR code (2 Periods)
- Basics of GIS (1 Periods)
- Hands on training of network and communication systems (3 Periods)
- Trouble Shooting of Networks and communication systems (3 Periods)

XIV. Environmental Monitoring (10 Periods)

- **Chemistry of the Atmosphere-** Chemical and photochemical processes, mass-momentum continuity equation, chemical and dynamical lifetime of atmospheric constituent.

Atmospheric Ozone Evolution of the ozone layer, Sources and sinks of ozone, Chlorofluorocarbons, Ozone hole, Ozone and UV-radiations, Impact of Supersonic transport. Measurement of Total Ozone, Vertical distribution of ozone, (Ozone Sonde)

- Aerosol (Types, Formation, Radiative Properties, Climate Impacts)
- Green House Gases (Sources, Climatic Impacts, Measurement Techniques)
- **Emission inventory**- Emission and concentration of pollutants, Various sources of emissions, anthropogenic emissions, bio-mass burning, pollution formation in fossil fuel combustion, bio-fuel, industries, suspended dust, power plants and forest fires. Impact of air pollution on Human health and vegetation.

XV. Seismology (10 Periods)

- Introduction to Seismology; Internal structure of the Earth, Plate tectonics, Physics of earthquake processes; Types of faults and fault mechanisms; Seismicity and Seismotectonic features of India.
- Earthquake source parameters; Magnitude, intensity, energy; etc.; Earthquake statistics; digital data analysis and location of earthquakes; Seismological operations and information dissemination.
- Seismic instrumentation – Sensors, recording systems, Communication systems, etc.; Local, regional and global networks; Micro-earthquake monitoring; Operation and maintenance of seismic equipment.
- Seismic Zoning; Seismic Hazard, Vulnerability & risk assessment; Seismic Microzonation; Disaster mitigation, management and preparedness.
- Early warning of tsunamis; Earthquake precursors & prediction

XVI. Positional Astronomy (2 Periods)

1) Basics of Positional Astronomy:

Definition of celestial sphere, Zenith, Nadir, Celestial Horizon, Celestial Pole, Celestial Equator, Meridian,

Ecliptic, First point of Aries and Libra (Definition only). Basic idea on three systems of celestial coordinates:

- i) Horizontal System
- ii) Equatorial System
- iii) Ecliptic system

2) Astronomical Parameters and Phenomena:

Precession and Nutation (Basic idea), Conjunction, Opposition, Elongation, Eclipses, Occultation and Transit of Planets over the Solar disc (Basic idea).

3) Calendric Astronomy

Different types of Calendar: (i) Solar, (ii) Lunar, (iii) Luni solar, (iv) Indian National Calendar and (v) Gregorian Calendar.

XVII. General Administration (24 Periods)

- General Office Procedures
- General Service Rules
- General Finance Rules
- Hindi and English noting & drafting
- History & evolution of IMD, organizational structure of IMD and its sub-offices i.e. RMCs, MCs, PAC Kolkata, mandate of different offices & divisions and brief introduction of the Ex-DGMs.

XVIII. Data Base Management (2 Periods)

- Platforms and use of data base management.
- Directory structure
- Contents
- Methods of data base structure
- Examples
