India Meteorological Department

Syllabus
For
Integrated Meteorological Training Course

(4 Months duration)
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
Mid-Term Exam = 3 days
Final Exam = 9 days (6 Theory & 3 practical)
Viva voce = 1day
Expected Gazetted Holidays = 5 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 4 periods each of 60 minutes duration in the Afternoon
- Total 7 periods in a day
Total number of periods available for training = 65 x 7 = 455

**Periods of teaching for each subject**

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<td>Visit to scientific / technical units</td>
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<td></td>
<td><strong>Total</strong></td>
<td><strong>455</strong></td>
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</table>
I. An Overview (10 Periods)

- Introduction to IMD, Its Mandate, Organizational structure.
- WMO, ICAO & Global climate observation system.
- Importance of meteorology, various branches of meteorology and their applications.
- 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.
- Weather, climate, Elements of weather, climate controls, weather phenomena, Semi-diurnal variation of pressure, Diurnal variation of temperature.
- 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).

II. Observational Systems (60 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 (25 Periods) [10 theory + 15 Practicals]

- 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.
- Thermometer: Dry Bulb, Wet Bulb, maximum and minimum – description, method of working, reading and resetting; Stevenson screen, exposure, care of instruments.
- Humidity – Definition, calculation of relative humidity from dry and wet bulb readings; Dew point temperature; Description and working of Assman and Whirling psychrometer.
• Wind instruments – Definition of wind, units, Beaufort scale; Wind vane and anemometer, description and. Working
• Rain gauge: - Description and working, measurement of rain.
• Snow Gauge: - Description and working, measurement of snow.
• 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.
• 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 thermograms
• ARG, AWS, Aviation Met Instrument including transmissometer & application, Agrometeorological and radiation instruments.
• Instruments for air quality, Ozone and Green house gases measurements.
• Emerging trend in Meteorological observations (Airborne / Shipborne etc.)

**Upper Air Observations (20 Periods = 5 theory + 15 practicals)**
• 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)

**Codes: (10 Periods)**
• Introduction, Surface (synoptic & asynoptic) (land & sea) codes, upper air codes, Temp code, exercises in coding and decoding.
III. Dynamic Meteorology (25 Periods)

- **Equation of Motion**: Frames of reference, Vector equation of motion in inertial & non-inertial frame (No derivation). Local tangential coordinate system. Equation of motion (in component form), explanation (without derivation) of all the terms. Pressure as a vertical co-ordinate & its usefulness. Horizontal equation of motion with pressure as a vertical co-ordinate. Atmospheric forces: Real & apparent forces, body & surface forces: Coriolis force, Pressure gradient force, Centrifugal force, Gravity and Gravitation.

- **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.

- **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.


- **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.
- **Conservation of mass:** Equation of continuity, Dines compensation principle, Concept of the level of non-divergence. Moisture continuity equation.

- **Divergence & vorticity:** Definition of Divergence and vorticity & their mathematical expression. Illustration by typical cases on synoptic charts.

- **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.

- **Practical 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 precipitable water content, Computation of geostrophic wind, thermal wind, thermal advection, moisture flux and vertical wind.

### IV. Numerical weather prediction (10 Periods)

- **Operational NWP applicat system:** Global Forecast System, Regional and mesoscale forecast system (WRF, ARPS), Nowcast model, multi-model ensemble technique, Storm Surge modeling.

- **NWP Products:** Different products: Direct and Derived, Post processing of model output: Model output verification, Down scale of NWP model like location specific forecast, NWP products for: aviation services, cyclone forecasting & warning, monsoon rainfall system, applicati severe weather, Western disturbances., NWP products in Web.

**Practical**

- Linux O.S, Configuration of WRF model with GFS, Experiment with nesting and nest down techniques, WRF data assimilation.

- Model diagnosis: Graphics package for illustration of NWP products, Case study of monsoon depression, cyclonic storm, applicati severe weather with the use of NWP products.
V. Physical Meteorology & Marine Meteorology (25 Periods)

**Theory (15 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
- General principles of radiation, Importance of radiation in the study of meteorology. Laws of radiation, units.
- 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 (10 Periods)**

- Plotting of the sounding data Dry bulb, wet bulb and Dew point curve construction. Graphical construction of LCL, CCL and level of free convection. Demarcation of positive and negative areas.
- Instability indices and calculation using T- Φ diagram
- Automated computation of above indices
VI. SYNOPTIC METEOROLOGY (55 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.
- Wind and pressure analysis: Isobars on level surface and contours on constant pressure surface. Isotherms, thickness field; examples of geostrophic, gradient and thermal winds: slope of pressure system, streamline and isotach analysis.
- Thunderstorm and severe local storm, synoptic conditions favorable for thunderstorm, concepts of triggering mechanism, conditional instability; Norwesters, dust storm, hail storm. Squall, tornado, microburst/cloudburst, landslide.
- 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,
- 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.
- Waves in mid-latitude westerlies, Western disturbance and its structure and associated weather
- Jet Streams – WMO definition of Jet stream, different jet streams around the globe, Jet streams and weather
- Meso-scale meteorology, sea and land breezes, mountain/valley winds, mountain wave.
- 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.

Practical (30 Periods)

- Decoding and plotting of surface and upper air data.
- Analysis of surface chart (pressure, temperature. Rainfall P24 P24 and pressure
departure).

- Kinematic (streamline and isotach) analysis of wind charts.
- Analysis of constant pressure charts.
- Analysis of vertical time section.
  - Station in easterlies
  - Station in westerlies
- Analysis of vertical cross-section for January and July.
- Analysis of surface and upper air charts of active monsoon with depression.
- Analysis of surface and upper air charts of break monsoon.
- Analysis of surface and upper air charts with western disturbance.
- Analysis of Jet streams and waves in upper tropospheric westerlies
- Familiarisation with numerical model outputs
- Synergie Familiarisation

## VII. AVIATION METEOROLOGY (45 Periods)

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<tr>
<th>TOPIC</th>
<th>Sub topic</th>
<th>Objective: On completion the trainees should be able to:</th>
<th>No. of Periods</th>
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<tr>
<td>An overview of Aviation Organizations and their functioning.</td>
<td>1. WMO, ICAO, Caem</td>
<td>List the mandate of the organizations</td>
<td>1</td>
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<tr>
<td></td>
<td>2. Components of ATM</td>
<td>Understand the functioning of ATC, Communication &amp; Met and their inter-dependability. Understand concept of FIR, FIC, AIP</td>
<td>1</td>
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</table>
| | 3. Functioning of IMD’s Aeronautical Met Organisations | 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. | 2 |
<p>| | 4. Provisions of CAR &amp; PANS-Met | Understand basics provisions and their own role and responsibilities as AMP. | 1 |
| Effect of Weather on aviation | 1. Effect of various atmospheric parameters on different phases of flight operation | Explain the effect of weather elements on aircraft operation | 1 |
| | 2. Weather hazards to aviation | List the weather hazards and explain its effect on aircraft operation | 1 |
| | 3. Climatology of Aerodrome | Understand broad features of climatology of hazardous weather for | 2 |</p>
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<th>Observation and reporting of weather for Aviation services (METAR/SPECI)</th>
<th>Generate and interpret climatological information from CW data and other available sources.</th>
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<td>1. METAR/ SPECI code</td>
<td>1. Explain the latest METAR/ SPECI code form and SPECI criteria</td>
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<td>2. SPECI Criteria</td>
<td>2. Prepare a METAR/ SPECI message using the given observations</td>
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<td>3. Reporting of meteorological elements in METAR/ SPECI</td>
<td>3. Explain the basic concepts of TREND forecast</td>
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<tr>
<td>4. Basic concepts of TREND forecast</td>
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<td>5. Prepare a METAR/ SPECI message using the given observations</td>
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<th>Observation and reporting of weather for Aviation services MET Report/ SPECIAL</th>
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<td>2. Difference in reporting of elements in METAR and MET Report</td>
<td>2. Prepare a MET REPORT/ SPECIAL message using the given observations</td>
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<td>3. Examples of preparation of MET REPORT/ SPECIAL</td>
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<td>1. Explain TAF code</td>
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<td>2. Decoding of the coded TAF into plain language message</td>
<td>2. Decode a coded TAF into a plain language message</td>
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<td>1. ROFOR Code</td>
<td>1. Describe ROFOR code</td>
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<td>2. Decoding of the coded ROFOR in plain language</td>
<td>2. Decode a ROFOR and prepare the route forecast in MET-T3/ MET- T4 format</td>
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<tr>
<td>3. Instructions on preparation of MET</td>
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<td>4. Instructions on preparation of MET</td>
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<td>5. Preparation of a route forecast in MET</td>
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<td>6. Preparation of a route forecast in MET</td>
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<th>Reporting &amp; dissemination of SIGMET,</th>
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<td>1. Template for SIGMET</td>
<td>1. Explain the SIGMET template</td>
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<td>2. Elements of SIGMET</td>
<td>2. Explain an actual SIGMET</td>
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<td>3. Its Rx and Tx</td>
<td>3. Rx/Tx and station included in India.</td>
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<td>1. Explain the responsibilities of AMO</td>
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| Warning, Warning for light aircrafts Wind shear warnings | AMO and AMS  
2. Warning elements  
3. Warning format | and AMS in relation to issuance of warnings  
2. List the warning elements  
3. Explain the format of the warnings and explain given a warning | 1 |
|---|---|---|---|
| TCAC and VAAC advisories | 1. Responsibility of TCAC and VAAC  
2. Template of TCAC advisory with example  
3. Template of VAAC Advisory with example | 1. List the responsibilities of TCAC and VAAC  
2. Explain the templates of TCAC advisory and VAAC advisory explain given advisories. | 1 |
| WAFC products | 1. Type of WAFC charts available  
2. Chart specifications  
3. Contents of charts  
4. Description of SIGWX elements depicted  
5. Interpretation of national and WAFC SIGWX charts | 1. List the WAFC products available  
2. Describe a given WAFS SIGWX chart and SIGWX chart.  
3. Sources and procedure for receiving the WAFC products | 1 |
| Briefing and documentation | 1. List of documents to be provided  
2. List of items to be displayed in met offices  
3. Briefing of low level flights  
4. OLBS-products available and its updation schedules and methods | 1. List the items to be provided in documentation  
2. List the items to be displayed in an aviation met office  
3. Explain the special requirements of low-level flights  
4. To download the products from OLBS or other sources. | 1 |
| ATN (Aeronautical Telecommunication Network) | 1. Basics about aeronautical telecommunication network  
2. Filing time, transmission time and priority of various aviation meteorological messages  
3. Basic concept of ROBEX scheme  
4. Basics of VOLMET broadcast | 1. Explain the aviation telecommunication network  
2. filing time and transmission time of aviation met messages  
3. Explain ROBEX scheme  
4. Explain VOLMET | 1 |
| Accident Investigation | 1. Introduction  
2. Responsibilities of a Met observer | 1. Explain the procedures to be followed by various offices | 1 |
### VIII. Climatology, Statistics & Data Base Management (45 Periods)

**Section-A: Climatology (15 Periods)**

- Climatic and Classifications of climate
- Indian Climatology – Four Seasons
- Winter season – Western disturbance and Easterly waves and weather associated with them. Fog, cold wave, Thunderstorm and Hail Sub-tropical westerly Jet stream.
- Premonsoon 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.
- 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.
- Post Monsoon season: Withdrawal of southwest monsoon and northeast monsoon, Cyclonic storms in the Indian seas, Western disturbances, easterly waves.
- Paleo Climatology and Bio Climatology
- 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.
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. (1 Period)

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. (1 Period)

Correlation analysis: Definition, examples, scatter diagram, Pearson’s co-efficient of correlation, merits and demerits, correlation analysis in meteorology, non-linear relation. (1 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)

Multiple regression analysis: Definition, regression equation with two independent variables, extension to more variables, partial correlation co-efficients, multiple correlation co-efficient, screening regression (introduction only), application in forecasting of met variables. (1 Period)

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. (1 Period)

- **Time series analysis:** Definition of a time series, examples (meteorological), components of a time series (trend, seasonal cyclic and random variations), auto correlation co-efficient, its statistical significance, correlogram, random time series, stationary time series, markov series. (2 Periods)

- **Harmonic and spectral analysis:** Definition of both, objectives, periodogram of a time series, computation of power spectrum, statistical significance, filters, effective length of a stationary time series. (2 Periods)

**Practical (10 Periods)**

For practicals, the traditional way of computing i.e. manual mode should be used only sparingly. The trainee should be encouraged to execute the computation of statistical parameters like, averages, deviations, correlation, spectra etc. through computer only. Most of the computations and preparation of diagrams can be carried out thru excel spread sheet. In practicals and exercises, meteorological and hydrometeorological data should be utilized. Over all every effort should be made towards imparting training in statistics as applied to meteorology.

**Section - C: Data Base Management (5 Periods)**

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

**IX. Basics of Satellite Meteorology (10 Periods)**

- Principles of remote sensing, Introduction to basic principles of satellite meteorology, Orbital mechanics, Meteorological satellites, Polar orbiting and geostationary satellites, Current and future meteorological satellites of the world, Payloads on Meteorological satellites, INSAT, Kalpana, Megha-Tropiques, Oceansat-II, NOAA, Metop etc. DMDD receiving system, DTH based DCWDS, Satellite data reception and processing, Ground based GPS system and retrieval of IPWV.
• Interpretation of Satellite Images: Characteristics of various channels, identification of typical clouds and weather systems from cloud imageries, Use of various satellite-derived products, Satellite bulletin and its interpretation. Tropical cyclones, their identification and grading using Dvorak’s technique. Applications of satellite data/products in Agro-meteorology and aviation. Interpretation of microwave channel images.

X. Basics of Weather Radars and Radar Meteorology (15 Periods)

• Introduction to Weather radars. Different frequency bands used in the weather radars and their applications. Principles of pulsed radar, Polarimetric radars.
• Attenuation of EM Waves v/s wavelength. Scattering of EM waves (Rayleigh & Mie). Bending of radar beam with refraction (Sub & Super refraction). Effect of curvature of the Earth on the range of radar.
•Definitions of Beam width, Pulse width, PRF, Antenna gain, back scattering cross section, Reflectivity factor (\(\eta\)) and radar reflectivity factor (\(Z\)).
• Radar equation for a point target and for extended target. Concept of dB, dBZ, dBm & dBW.
• Principle of Doppler Weather radar. Block diagram of Doppler Weather radar and explanation of its major components. Introduction to magnetron, Klystron, waveguides and Ferrite Circulator.
• Operation procedure of DWR – volume scans, scheduler mode of operation and product generation – on line and offline. Uniform Scan strategy used in IMD Doppler radars.
• Radar calibration, validation, Radar data dissemination and data archival.
• Broad principles of different system software – RAINBOW and IRIS. Introduction to advanced radars like Solid state and Phased array radars, Use of test equipments in radar maintenance, Product algorithms.
• Derived DWR products – their interpretation and use in Nowcasting
  ➢  Reflectivity (PPI, CAPPI, PCAPPI, MAX, VCUT, EBASE & ETOP)
  ➢  Radial Velocity (PPI, CAPPI, PCAPPI, MAX, VCUT, VVP_2)
  ➢  Spectrum Width (PPI, CAPPI, PCAPPI, MAX, VCUT, Layer Turbulence)
  ➢  Hydrological Products (SRI, PAC, VIL)
Warning products (Severe Weather Index, HHW) Analysis of severe weather events (thunderstorms, hailstorms, line squall, heavy rainfall prediction, aviation safety and tropical cyclones) recorded by DWR and development of the nowcasting technique for their prediction.

XI. Agricultural Meteorology (10 Periods)

- **Concept of Agricultural meteorology**: Introduction to Agrometeorology, Scope and importance of agrometeorology, Familiarization with important activities of Agrimet Division

- **Agromet observatory/Agromet observations**: Agromet instruments their installation, Maintenance, Inspection of observatories, Time of observations, use and archival

- **Software on GIS database**: Applications of remote sensing and GIS in agrometeorology, products generation

- **Agroclimatic Zones**: General concept, criteria for climatic classification, climatic classification in India Objectives, Agroclimatic, 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.

- **Crop phenology and Agroclimatology of field crops**: Crop phonological stages, their identification in crop weather study, Preparation of crop weather calendar its use for operational work, Agroclimatic requirement of major field/horticultural crops, applications

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

XII. Upper Air Instrumentation (20 Periods)

**Basic Electricity and Electronics**: 10 Periods

• Overview of – Power supply circuits and applications: SMPS, variable and fixed.
• Basic amplifier concepts. Operational amplifier applications – IC based oscillators including quartz oscillators. RF Oscillators with examples.
• Modulation types with wave diagrams. RF Amplifiers, IF amplifiers, Super heterodyne receivers, Mixers. Range of Audio and video frequency bands. Attenuation and measurements in decibels.
• 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.

**Introduction to Radiosonde/ Radio wind Systems. (UAL)**

10 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.
• Introduction to Windprofiler, 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)
### XIII. Surface Instruments (35 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:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Met element</th>
<th>Reading instruments</th>
<th>Recording instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Temperature</td>
<td>DB, WB, Max., Min. thermometers/ Thermometer screen</td>
<td>Bimetallic Thermograph</td>
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<tr>
<td>2.</td>
<td>Relative Humidity</td>
<td>DB-WB Thermometer, Psychrometer (Whirling and Assmann types)</td>
<td>Hair Hygrograph</td>
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<td>3.</td>
<td>Precipitation</td>
<td>Non Recording Rain gauges, Rain Measures, different types of Clock Drums (Mechanical/ Quartz type)</td>
<td>Self Recording Raingauges, Tipping Bucket Raingauges</td>
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<tr>
<td>4.</td>
<td>Surface wind</td>
<td>Cup Counter Anemometer, Mechanical wind vane, Portable wind vane. Methods of installation of wind instruments with respect to True North etc. Sensitivity of Anemometer.</td>
<td>Brief discussion on DPTA, Identification and rectification of defects in DPTA.</td>
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<tr>
<td>5.</td>
<td>Atmospheric Pressure</td>
<td>Mercury Barometers, Aneroid Barometers, Precision Aneroid Barometers, Comparison of mercury barometers</td>
<td>Microbarograph</td>
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<tr>
<td>6.</td>
<td>Duration of sunshine</td>
<td></td>
<td>Campbell Stoke's Sunshine Recorder</td>
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<td>7.</td>
<td>Solar Radiation</td>
<td>Brief discussion on Pyrheliometer, Pyranometer</td>
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<tr>
<td>8.</td>
<td>Evaporation</td>
<td>Open Pan Evaporimeter</td>
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<td>9.</td>
<td>Familiarization with the Inspection Kit box items and its usage in the field, non-instrumental observations (viz. visibility, cloud).</td>
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</tr>
<tr>
<td>10.</td>
<td>Inspection of surface meteorological observatories.</td>
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<td></td>
</tr>
</tbody>
</table>
Automatic Weather Station/Automatic Rain Gauge (Theory + Practical): 12 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 and their characteristics, slope and offset calculations for a linear analog output sensor, 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.

- **CALIBRATION PROCESS:**
  Calibration procedures for various sensors in temperature chamber, pressure chamber, wind tunnel etc. laboratory and field testing of 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

**AIRPORT METEOROLOGICAL INSTRUMENT**

- **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.

• **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**  05 Periods

• General requirement of Radiation instruments, measurement of sunshine, and intensities of solar radiation.

• Importance of radiation in the study of meteorology.

• Laws of radiation, units.

• General principles of radiation measuring instruments and methods of observation.

• Pyranometers, Pyrheliometers etc.

• Measurement of direct, global, diffuse and reflected solar radiation.

• Thermoelectric Pyrgeometer for net terrestrial radiation (Continuous measurements) and Net pyradiometer for total net radiation.

• Measurement of UV radiations with UV radiometers.

• Operation of micro computer 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.
XIV. Meteorological Telecommunication and Information Technology (45 Periods)

- Concept of communication of HF, VHF, UHF and Microwave, GSM and GPRS (02 Periods)
- Data formats (ASCII, Binary, HDF, NetCDF and BUFR) (02 Periods)
- Operating systems- WINDOWS, LINUX and Data base management (05 Periods)
- Networking- LAN, WAN, Optical fibre, Switches, Modems and Routers, OSI 7 layer structure, Protocols, IPV4 & IPV6, IP Scheme, NKN, VPN, Internet & ISPs, FTP, TCP/IP socket communication, Telnet, SSH (08 Periods)
- Web Services: - Basic Web designing using html, PHP & Java and use of IMD intranet (08 Periods)
- Introduction to Met. Communication Systems (HSDT, VSAT, IVRS, AMSS, CIPS and Synergie) (05 Periods)
- GTS WMO Procedure & Protocols: - WIS, GISC, DCPC, NC, Meta data, WMO Headers and Data Routing procedures (05 Periods)
- Basics of GIS (02 Periods)
- Hands on training of network and communication systems (04 Periods)
- Trouble Shooting of Networks and communication systems (04 Periods)

XV. Environmental Monitoring (10 Periods)

- Formation Mechanism, Destruction of Ozone
- Ozone Hole, International Efforts to protect Ozone hole
- Measurement of Total Ozone, Vertical distribution of ozone (Ozone Sonde), Surface Ozone
- Aerosol (Types, Formation, Radiative Properties, Climate Impacts)
- Green House Gases (Sources, Climatic Impacts, Measurement Techniques)
- Air Quality (Types of Sources, Impacts, Wind Roses, Measurement Techniques)
XVI. Seismology (15 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.
- Elastic Wave theory: Seismic wave propagation & characteristics, Travel-time tables and Velocity models.
- 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

XVII. Positional Astronomy (02 Periods)

1) Basics of Positional Astronomy: (1 Period)
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) Calendric Astronomy (1 Period)
Different types of Calendar: (i) Solar, (ii) Lunar, (iii) Luni solar, (iv) Indian National Calendar and (v) Gregorian Calendar.

XVIII. General Administration (03 Periods)

- General Office Procedures
- General Service Rules
- General Finance Rules