India Meteorological Department

Syllabus
For Intermediate Course in
Meteorological Instrumentation and
Information System (MI&IS)
The intermediate course in MI&IS consists of one month of self learning module and three months of class room contact programme. Syllabus of both are enclosed.

**Class room contact programe:**

Total duration = 3 Months  
Number of working days in one working month = 21  
Total number of working days= 3 x 21= 63 days  
Joining & induction= 1 day  
Relieving = 1 day  
Exam = 5 days  
Viva voce = 1 day  
Number of working days available for training = 63-8=55 days  
Number of periods in one working day : 6 periods + 1 Library period  
Total number of periods available for training = 55 x 6 = 330  
Theory Periods: 180  
Practicals Periods: 150
Self Learning Module (One Month)

1. Basic Electricity and Electronics


- 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.


- 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.


2. Surface Observations

- 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.)

3. Upper Air Observations

• 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)

4. AVIATION METEOROLOGY

   Airport Meteorological Instruments, Basic functions and use of airport meteorological system

5. Basics of Solar Radiation


6. 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.
Class Room Contact Programme

(i) Basics of Weather Radars and Radar Meteorology (20 Periods)

- Introduction to Weather radars. Different frequency bands used in the weather radars and their applications. Principles of pulsed radar, Polarimetric radars.
- 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.
- 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, V/CUT, EBASE & ETOP)
  - Radial Velocity (PPI, CAPPI, PCAPPI, MAX, V/CUT, VVP_2)
  - Spectrum Width (PPI, CAPPI, PCAPPI, MAX, V/CUT, 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.
(ii) Upper Air Instrumentation (20 Periods)

Basic Electricity and Electronics:
- Overview of – AC and DC voltages, Reactance and impedance in capacitors and inductors. Phase diagrams.
- Basic amplifier concepts. RF & AF Amplifiers, Classification of amplifiers, amplifier coupling methods. Oscillators –Sinusoidal oscillator –types of oscillators, positive feedback amplifier.
- Operational amplifier – Characteristics of Ideal Op–Amp, its parameters and Applications.
- Modulation types with wave diagrams. Super heterodyne receivers.
- 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)
- 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.
- Meteorological Balloons- Types of balloons used for RS ascents, Filling & Launching.
- Global climatological observing System (GCOS System).

(iii) Surface Instruments (35 Periods)

(i) 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 of faults. A list of instruments that will be 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>
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<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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<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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<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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<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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<td>6.</td>
<td>Duration of sunshine</td>
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<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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<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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<td>10.</td>
<td>Inspection of surface meteorological observatories.</td>
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<td>11.</td>
<td>Calibration of equipments and methods of calculation of Met. Parameters.</td>
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(ii) **Automatic Weather Station/Automatic Rain Gauge (Theory + Practical): 12 Periods**

- **AUTOMATIC WEATHER STATIONS/AUTOMATIC RAINGUAGE 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

(iv) **AIRPORT METEOROLOGICAL INSTRUMENT**

**15 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.
• 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

(v) RADIATION INSTRUMENTS 05 Periods

  (i) General requirement of Radiation instruments, measurement of sunshine, and
      intensities of solar radiation.
  (ii) Importance of radiation in the study of meteorology.
  (iii) Laws of radiation, units.
  (iv) General principles of radiation measuring instruments and methods of
       observation.
  (v) Pyranometers, Pyrheliometers etc.
  (vi) Measurement of direct, global, diffuse and reflected solar radiation.
  (vii) Thermoelectric Pyrgeometer for net terrestrial radiation (Continuous
        measurements) and Net pyrradiometer for total net radiation.
  (viii) Measurement of UV radiations with UV radiometers.
  (ix) Operation of micro computer controlled Sun tracker.
  (x) Familiarization with uses of UV/NIR/Vis range Spectrophotometer.
  (xi) Operation and maintenance of data loggers for radiation measurements.
       Calibration, Maintenance and rectification of defects of Radiation instruments.

(vi) Meteorological Telecommunication and Information Technology
     (45 Periods)

• Concept of communication of HF, VHF, UHF and Microwave, GSM and GPRS
• Data formats (ASCII, Binary, HDF, NetCDF and BUFR)
• Operating systems- WINDOWS, LINUX and Data base management
• 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
• Web Services: - Basic Web designing using html, PHP &Java and use of IMD
  intranet
• Introduction to Met. Communication Systems (HSDT, VSAT, IVRS, AMSS, CIPS
  and Synergie)
• GTS WMO Procedure & Protocols: - WIS, GISC, DCPC, NC, Meta data, WMO
  Headers and Data Routing procedures
• Basics of GIS
• Hands on training of network and communication systems
• Trouble Shooting of Networks and communication systems

(vii) Basics of Satellite Meteorology (15 Periods)

(i) 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-1, Megha-Tropiques, Oceansat-II, INSAT-3D, Saral-AltiKA, NOAA, Metop etc. DMDD receiving system, DTH based DCWDS, Satellite data reception and processing.

(ii) Ground based GPS system and retrieval of IPWV.

(iii) Brief Interpretation of Satellite Images and products, 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.

(viii) 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), Aerosol Measurement techniques.
• Green House Gases (Sources, Climatic Impacts, Measurement Techniques)
• Air Quality (Types of Sources, Impacts, Wind Roses, Measurement Techniques)
• Acid rain and wet only precipitation collection.

(ix) General Seismology and instrumentation (15 Periods)

(i) Introduction to Seismology and earthquakes, causes of earthquakes, types of seismic waves, basic types of faulting, earthquake source parameters and their determination. Various types of magnitude scales, seismic intensity, seismicity and seismic zoning of India, seismic hazard and tsunamis.

(ii) Introduction to seismic instrumentation, principles of inertial pendulum seismographs, working principle of Wood Anderson seismograph and Electromagnetic seismograph, various sensor parameters, classification of seismic sensors, working principle of broadband seismometer and strong motion accelerograph. Digital versus Analog recording, principal units of digital seismograph, analog to digital conversion process, data formats; various trigger
algorithms and their implementation. VSAT communication and real time data reception.

(iii) Seismic Networks (Local, Regional and Global) and examples of some existing seismic networks. Daily, weekly and monthly checks for monitoring of the performance of equipment and networks.

(iv) Working principle of earthquake autolocation software and earthquake report dissemination system.

(v) Site selection, pillar construction and installation of seismic equipment.

Practicals

1. Electricity and Electronics 20 Periods
   a) Identification of resistances/ capacitors: their colour code, value of resistance, tolerance, wattage etc. For capacitors to identify the type of capacitors, polarity, read the values of capacitance and working voltages etc.
   b) Use of Multi-meter: Measurement of very low and very high DC and AC voltages, resistances, currents, diodes etc.
   c) Use of Oscilloscope: To understand basic functions of a oscillo-scope. Use it to monitor and measure AC and DC voltages. To measure various pulses width and heights using signal generator.
   d) Basic Power Supply Circuit: construction and verification of a 05 or 12 V DC power supply using a step-down transformer, a bridge rectifier, a filter capacitor and a voltage regulator. To draw wave forms at various test points to understand the unit.
   e) Construction of 555 multi vibrator circuits – mono-static, bi-static and free running types.

2. RADAR 32 Periods
   (i) Visit to Radar station
   (ii) Identification of Various radar parts – Klystron, Magnetron, wave guides, feed horn, slip-ring assembly, servo motors, gear box systems, RF couplers/ circulators, cooling systems etc., and making a notes on this. Use of RF power meter in a radar station to measure Radar forward and reverse powers and to measure the VSWR.
   (iii) Study and interpretation of basic DWR products – 10 numbers

3. Visit to RMO, Ayanagar 15 Periods
   Understanding of GPS Sonde system, its receiver and various parts, other ground equipments being used for RS/RW ascents, RS/RW instrument preparation and ascents, understanding & decoding of Temp Message

4. Visit to Calibration/Testing /Hygristor Laboratory 3 Periods
5. Visit to Workshop 3 Periods
6. Visit to Ozone centre 3 Periods
7. **Surface/Radiation Meteorological Instruments** - Practice & observations  
   24 Periods

8. **Information System**  
   20 Periods
   
   (i) On Job Training in RTH Computer regarding Data reception & Transmission.
   (ii) Practice on FTP & Telnet.
   (iii) Operation of Projector with PC / Laptop
   (iv) PC and peripherals Hardware hands on training:

9. **Satellite Meteorology**: Operation of *MDD* and *DCWDS* equipment, GPS  
   15 Periods

    15 Periods

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