

GOVERNMENT OF PAKISTAN

Pakistan Meteorological Department

[www.pmd.gov.pk](http://www.pmd.gov.pk)

*Professional Training  
Courses*



PMD

Institute of Meteorology & Geophysics  
KARACHI

# **PROFESSIONAL TRAINING COURSE**

## **INTRODUCTION**

Pakistan Meteorological Department (PMD) offers professional training courses in various branches of Meteorology, Geophysics and allied sciences at the Institute of Meteorology and Geophysics (IMG), Karachi. The Institute established in 1960, provides training to the serving personnel of Pakistan Meteorological Department and also offers training facilities to persons belonging to other departments. Trainees from Meteorological Services of other countries are also welcome. The courses are of various levels and are designed for the new-comer to Meteorology as well as for those who have acquired sufficient experience in the field and require higher training. The syllabi of courses provided at the Institute have been prepared mainly according to redefined classification of meteorological personnel and the pattern recommended in the World Meteorological Organization (WMO) Technical publication No. 258 (2nd Edition) and No. 114 (2nd Edition). In terms of the new classification system, there are two categories of meteorological personnel (i) graduate professionals, meteorologist and meteorological technicians (ii) within each of which there are three career development levels (entry level, mid level and senior level). The training programme recommended for the two types of personnel are the Basic Instructional package for Meteorologists (BIP-M) and Basic Instructional Package for Meteorological Technicians (BIP-MT).

The courses aim is to provide both theoretical and practical background to a student and to equip him fully for the job; he is to take up after completion of his training. Lectures by topics in Physics and Mathematics are included in the regular courses. The Institute has its own library and a good collection of text books are available for the benefit of the students. New books and publications are added from time to time.

Adequate emphasis is laid on practical and professional aspects of the subject at the Institute and is supplemented by on-the-job training at one of the Meteorological Forecasting Office. Medium of instruction is English. Candidates from abroad desiring enrolment are to be sponsored by their respective Government. Candidates from other departments are to be nominated by appropriate authorities.

On successful completing On-Job-Training, certificates are awarded to students. Evaluation reports on the completion of training are also sent to the sponsoring authority, on request.

## **TRAINING COURSES AND PROGRAM**

Meteorological training courses offered at the Institute are of two types:

- a. Regular Courses
- b. Special Courses

Regular courses are run on routine basis while special courses, which are generally of shorter duration, are conducted as and when required.

Four regular courses in meteorology are being conducted for Pakistan Meteorological Department (PMD) different categories of meteorological personnel as shown below:

- i. Initial Meteorology Course for WMO category IV Meteorological Personnel.
- ii. Preliminary Meteorology Course for WMO category III Meteorological Personnel.
- iii. Basic Forecasting Course for WMO category II Meteorological Personnel.
- iv. Advance Meteorology Course for WMO category I Meteorology Personnel.

The training of fresh personnel is started from initial stage and is gradually taken up to higher levels as required

### **Seismic Courses**

PMD has gained ground by switching to digital seismic equipment for expansion of its network which requires specialized personnel. In order to enhance the capabilities in fields of seismic monitoring, instrumentation, data communication, hazard evaluation and tsunami warning in the expanding digital seismic network, PMD requires professionally motivated and skilled staff. For this purpose two seismological courses (Preliminary Seismological Course and Advance Seismological Course) were designed.

These courses will enhance the capabilities of the professionals working at various seismic stations. The courses will also provide a base for young scientists to flourish in research oriented tasks.

### **PROGRAMME OF COURSES AND ENROLMENT**

Generally two Initial, two Preliminary one Basic Forecasting Course and one Advance Meteorology Course; are held each year and its schedule is circulated by the end of August to all concerned agencies.

After the completion of the training courses, the students are assigned on-the-job training for four (4) to thirty two (32) weeks. Refresher courses in all categories of regular courses are also held for shorter duration as and when considered necessary.

### **NOMINATIONS**

#### **Departmental Candidates**

The serving personnel are nominated by various unit of the Pakistan Meteorological Department according to their rank, experience and qualification.

#### **Non-Departmental Candidates**

Non-Departmental candidates are to be nominated by their respective departments.

**Candidates from Foreign Countries**

The sponsoring authorities may send their request to the Director-General Pakistan Meteorological Department, Met Complex, P.O Box No.8454, University Road, Karachi-75270, Pakistan.

**MEDICAL FACILITIES**

Government rules are applicable for medical treatment reimbursement for Pakistani/departmental students.

Medical treatment charges if any will not be reimbursed during training for foreign students, however a small medical dispensary is available within Institute campus for minor treatment for all students.

**ACCOMMODATION**

Hostel accommodation is available and mandatory, and is provided on payment of nominal charges.

**ADDRESS**

The address of the Institute is:

Director,  
Institute of Meteorology and Geophysics,  
Meteorological Complex, University Road,  
Post Box No.8454, Karachi-75270, Pakistan

**TELEPHONE**

0092-21-99261408  
0092-21-99261409  
0092-21-99261411

**FAX** 0092-21-99261409  
0092-21-99261405

**E-MAIL ADDRESS**

pmdimg@hotmail.com  
pmdimg@yahoo.com

(ARIF MAHMOOD)  
Director General

**INSTITUTE OF METEOROLOGY AND GEOPHYSICS**

*Programme and syllabi*  
TRAINING COURSES IN  
METEOROLOGY AND GEOPHYSICS

*With the Compliments of*  
*Director-General*  
*Pakistan Meteorological Department*

## Basic Instruction Package for Meteorological Technicians

### BIP-MT (Entry Level )

#### Initial Meteorology Course (14 weeks duration)

S.No.	Course No.	Particulars / Subject	Credit
1.	BIPMT 101	Elements of Earth Science	2 + 0
2.	BIPMT 102	Introduction to Meteorology	2 + 0
3.	BIPMT 103	Introduction to Aeronautical Met.	2 + 0
4.	BIPMT 104	Meteorological Instruments	2 + 1
5.	BIPMT 105	Surface Observation	1 + 3
6.	BIPMT 106	P.B.O.	1 + 1
7.	BIPMT 107	Codes	3 + 0
8.	BIPMT 108	Plotting	0 + 4
9.	BIPMT 109	Tabulation of Data	0 + 2
10.	BIPMT 110	Introduction to Computer	1 + 2

Examination ..... 2 weeks  
 On-Job-Training ..... 4 weeks

## **BIPMT 101 Elements of Earth Science**

### **The Solar System**

- Theories about its origin
- The formation of Sun and Planets
- Kepler's laws of Planetary Motion.

### **The Earth**

- Structure and properties of the Earth
- Motion of the Earth (Revolution & Rotation etc.)
- Earth's coordinate system
  - (i) Latitude and Longitude
  - (ii) Time Zones
- Some properties of Land & Water
- Seasons & climate belts

### ***Books Recommended:***

- i) **Compendium of Lecture Notes for Training**, by B.J. Retallic, WMO No.266 T.P.150 Class-IV Meteorological Personnel Vol-I, Earth Sciences Geneva, Switzerland. 1982.
- ii) **Earth Science**, by Edward (12<sup>th</sup> Edition 2009), J. Tarbuck and Frederick K., Lutgens, Charles E. Merrill Publishing Company, London

## **BIPMT 102 Introduction to Meteorology**

### **Atmosphere**

- Composition and structure of the atmosphere
- Heat exchange processes in the atmosphere

### **Weather Elements**

- Temperature
- Atmospheric pressure
- Wind force
- Moisture contents of Air & Soil
- Visibility
- Clouds
- Parameters reducing visibility

### **Clouds and Precipitation**

- Clouds formation and types
- Stability of atmosphere
- Precipitation process

### **Synoptic Meteorology Introduction**

- Scales of motion and atmosphere
- Weather disturbances ; Tropical Cyclones, Anticyclones, Fronts
- Air masses
- Wind circulations
- Introduction to weather charts



**Books Recommended:**

- i) **Compendium of Lecture Notes for Training**, by B.J. Retallic, WMO No.266 T.P.150 Class-IV Meteorological Personnel Vol-I, Earth Sciences Geneva, Switzerland. 1982
- ii) **Introduction to Meteorology** by Severre Petterssen (2<sup>nd</sup> Edition, 1958), McGraw Hill Book Co., NY, USA.
- iii) **Introduction to the Atmosphere** by H. Riehl., McGraw Hill Book Co., NY, USA. 1965

**BIPMT 103 Introduction to Aeronautical Meteorology**

- Aviation Hazards phenomena
- Meteorological Aspects of Flight Planning
- Definition of Aviation terms
- Air Traffic Services
- Metar and Speci
- TAFOR & RoFOR

**Books Recommended:**

- i) **Handbook of Aviation Meteorology** by Her Majesty's. H.M.S.O., Stationary Office, London. 1960
- ii) **International Standard and Recommended Practices, Meteorological Series for International Air Navigation Annex-3** (11<sup>th</sup> Edition), International Civil Aviation Organization.

**BIPMT 104 Meteorological Instruments**

*(Functions, Principles & Maintenance of each)*

**Part I : Manual Instruments**

- Barometer (KP, Fortin, Aneroid)
- Thermometer (Dry, Wet, Max, Min.)
- Psychrometer
- Soil Thermometer
- Wind Instruments
- Rain Gauges
- Optical Theodolite
- Sunshine Recorder
- Nephoscope

**Part II : Self Recording Instruments**

- Barograph
- Thermograph
- Hair Hygrograph, etc.
- AWS & Sensors / Data Logger

**Books Recommended:**

- i) **Hand Book of Met. Instrument** by H.M.S. Office London Part-I Met.0577. 1956
- ii) **Observer's Hand book** by H.M.S. Office London N.0554. 1956
- iii) **Instruction to Observers** by Pakistan Meteorological Department. 1959
- iv) **WMO Guide to Met. Instruments & Observing practices**, WMO No.8.T.P3, Geneva, Switzerland.

## **BIPMT 105 Surface Observation**

- Recording of routine observations
- Preparation of coded weather messages
- Entry of observations in relevant meteorological forms/registers
- Barometric corrections and reduction
- Reading of special observations
- Radar & Satellite image reading

### ***Books Recommended:***

- i) **Instructions to Observers** by Pakistan Meteorological Department (1959).

## **BIPMT 106 Pilot Balloon Observation (P.B.O.)**

- Introduction
- Setting of theodolite
- Computation
- Ascent with and without tail
- Night ascent
- Selection of balloon and preparation
- Preparation of coded messages
- Gas preparation

### ***Books Recommended:***

- i) **The measurement of Upper Winds** by means of Pilot Balloon, H.M.S. Office, London.
- ii) **Handbook of Met. Instruments**, Part-II, M.O.557, H.M.S. London. 1961
- iii) **Technical Instruction for Pilot Balloon Station**, by Pakistan Met. Department. 1961

## **BIPMT 107 Codes**

### **Surface Codes**

- Synoptic Message

### **Upper Air Codes**

- Pilot Balloon Codes
- Temp Codes

### **Aeronautical Codes**

### **Table Driven Code Form**

### ***Books Recommended:***

- i) **Surface Weather Code** by PMD 1995 to 2008
- ii) **Ship Code** by Pakistan Meteorological Department 1995 to 2005
- iii) **Pilot Code** by Pakistan Meteorological Department 1995 to 2005
- iv) **Temp Code** by Pakistan Meteorological Department 1995 to 2005
- v) **Neph Code** by Pakistan Meteorological Department 1995 to 2005

vi) **Aeronautical Code** by Pakistan Meteorological Department 1996

### **BIPMT 108 Plotting**

- Surface Charts
- Pilot Charts
- Constant Pressure Charts
- 24 hours change charts
- Introduction to Computer based Plotting

### **BIPMT 109 Tabulation of Data**

- MMR (Monthly Meteorological Register)
- ACWR (Aviation Current Weather Register)
- Tabulation of Upper Winds
- Monthly Upper Air Register
- Different monthly statements

### **BIPMT 110 Introduction to Computer**

- Computer Knowledge
- Sending and Receiving E-mail
- Tabulation Using Excel sheet
- Microsoft Office (Word, Excel)
- Simple Statistical Analysis

#### ***Books Recommended:***

- i) **A Fundamental Course of Computer** by M. Sohail, Pak. Met. Deptt.
- ii) **MS Window user's guide and reference manual** by IBM Corporation.

## Basic Instruction Package for Meteorological Technicians

### BIP–MT (Middle Level)

#### Preliminary Meteorology Course (18 weeks duration)

S.No.	Course No.	Particulars / Subject	Credit
1.	BIPMT 201	Earth Science	2 + 0
2.	BIPMT 202	Atmospheric Thermodynamics	3 + 0
3.	BIPMT 203	General Meteorology & Climatology	4 + 0
4.	BIPMT 204	Meteorological Instrument	2 + 2
5.	BIPMT 205	Remote Sensing, Radar & Satellite Met.	1 + 0
6.	BIPMT 206	Observations & Tabulation	1 + 3
7.	BIPMT 207	Codes	4 + 0
8.	BIPMT 208	Plotting and Analysis	2 + 2
9.	BIPMT 209	Aeronautical Meteorology	1 + 1
10.	BIPMT 210	Computer Practice	2 + 1
11.	BIPMT 211	Upper Air Observation	0 + 3

Examination ..... 2 weeks  
 On-Job-Training ..... 8 weeks

## **BIPMT 201 Earth Science**

### **The Solar System**

- Theories about its origin
- The formation of Sun and Planets
- Kepler's laws of Planetary Motion

### **Planet Earth**

- The sun and its electromagnetic spectrum
- The dimension and structure of the Earth
- Motion of the Earth ; Rotation, Revolution, Precession.
- Time Zones
- International date line
- Seasons & Climate belts

### **Map Projections**

- Cylindrical projection
- Conical projection
- Zenithal projection

### **Books Recommended:**

- i) *Compendium of Lecture Notes for Training*, by B.J. Retallic, WMO No.266 T.P.150 Class-IV Meteorological Personnel Vol-I, Earth Sciences Geneva, Switzerland. 1987
- ii) *Earth Science* by Edward J. Tarbuck and Frederick K. Lutgens, 3<sup>rd</sup> Edition, Charles E. Merrill Publishing Company, London 2009
- iii) *Map Projections* by George P. Kellaway, (2nd Edition). Methuen & Company, London.
- iv) *Essentials of Physical Geography* by Robert E. Gablar., Brooke Cole., USA.
- v) *The Atmosphere : An Introduction to Meteorology* by Frederick K. Lutgens and Tarbuck Edward J, (9<sup>th</sup> Edition)., Prentice Hall, Upper Saddle River, New Jersey. 2012

## **BIPMT 202 Atmospheric Thermodynamics**

### **Elementary Thermodynamics of the Atmosphere**

- Composition of the Atmosphere
- Vertical Structure of the Atmosphere
- ICAO Standard Atmosphere
- Laws of Thermodynamics
- Thermodynamic processes
- Heat Exchange & Equilibrium

### **Equations of the Atmosphere**

- Atmospheric pressure and Hydrostatic Equation
- Gas Laws and equation of state for air
- Vertical Integration of Hydrostatic Equation
- Altimetry and Reduction of Pressure to sea level

### **Thermodynamic Properties of the Atmosphere**

- Definition of different parameters;  
Dew point temperature, Potential Temperature, Wet Bulb Temperature, Vapour Pressure, Mixing Ratio, Specific Humidity, Absolute Humidity, Relative Humidity

### **Thermodynamic Diagrams**

- Definition of Diagrams (Emphasis on T $\theta$ gram)
  - i) Plotting Temps Data on T $\theta$ gram
  - ii) Determining Thermodynamic Parameters

### **Parcel Method**

- Stability Analysis
- Different Types of Stability

### **Cloud and Precipitation**

- Basic processes of Cloud formation
- Basic processes of Rain Drop formation
- Various types of clouds
- Inversion layers & their properties
- Eddies and near surface turbulence

### **Books Recommended:**

- i) *Compendium of Lecture Notes* for training Class-III Met. Personnel, by B.J. Retallac, WMO No.291. 1971
- ii) *The Atmosphere : An Introduction to Meteorology* by Frederick K. Lutgens and Tarbuck Edward J, 9<sup>th</sup> Edition, Prentice Hall, Upper Saddle River, New Jersey 07458. 2012

## **BIPMT 203 General Meteorology & Climatology**

### **Part-I Dynamic Meteorology**

- Planetary, Synoptic and Mesoscale motions of the atmosphere
- Pressure patterns
- Configuration of trough, ridges, cyclones and anticyclones
- Pressure gradient force
- Corioliss force, Buys-Ballots law
- Pressure wind relationships
- The geostrophic wind
- The gradient wind
- The Thermal wind
- The cyclostrophic wind
- Friction effects on wind
- Horizontal convergence and divergence
- Convection and vertical motion of air

## Part–II Synoptic Meteorology

### Air Masses

- Sources
- Classification
- Thermodynamic characteristics
- Monsoon & Western disturbances

### Fronts

- Their formation and kinds
- Development and motion
- Wave development and formation of depression
- Weather associated with different kinds of fronts
- Computer based identification of fronts

### Cyclonic Disturbances

- Tropical cyclones (structure and formation)
- Tornadoes

### Local Winds

- Land and sea breeze
- Valley and urban winds
- Anabatic & Catabatic wind

## Part–III Climatology

- General circulation patterns
- Climatic elements factors and their controls

### Climate Classification

- Climate classification parameters
- Climate of the Globe
- Regional climate
- Climate of Pakistan
- Micro climatology

### Climate Change

- Global & Pakistan perspective
- Climate change assessment
- Impact of climate change on water, agriculture & weather pattern

### Books Recommended:

- i) **General Meteorology** by H.R.Byers, McGraw Hill Book Co., USA. 1959
- ii) **Introduction to the Atmosphere** by H. Riehl., McGraw Hill Book Co., NY,USA. 1965
- iii) **Introduction to Meteorology** by Petterssen, S., McGraw Hill Book Company, New York,USA. 1958
- iv) **Element of Dynamic Meteorology** by Gordon.A.H., The English University Press Ltd., New Gate Street, London.
- v) **The Meteorology of Pakistan** by K.M.Shamshad, Pak Met. Deptt. 1988
- vi) **The Atmosphere:An Introduction to Meteorology** by Frederick K. Lutgens and Tarbuck Edward J, 9<sup>th</sup> Edition, Prentice Hall, New Jersey. 2012
- vii) **Compendium of Lecture Notes in Climatology** for Class-IV Met. Personnel, by Prof.W.Lowry, WMO No.327., Geneva, Switzerland. 1974
- viii) **The Climate of Pakistan** by Jamil Ahmed Khan, Rehbar Publisher, Karachi, Pakistan. 1993

**BIPMT 204 Meteorological Instruments**

(Structure, Working principle, Errors, Maintenance & Exposure of each)

**Part–I Manual Instruments**

- Thermometers
- Barometer
- Wind vane
- Anemometer
- Rain gauge
- Evaporation tanks
- Sun shine recorder

**Part–II Self Recording Instruments**

- Barograph
- Thermograph
- Hygrographs
- Actinograph
- Anemograph

**Part–III Optical Instruments****Part–IV Electronic Instruments**

AWS, its sensors, Data logger

**Books Recommended:**

- i) *Met. Instruments and Observing practices*, WMO Guide, WMO No.9 T.P.-3., Geneva, Switzerland.
- ii) *Handbook of Met. Instruments* by H.M.S. O., London, Part I&II No.577. 1956
- iii) *Observer Handbook* by H.M.S. Office London, No.554. 1956
- iv) *Meteorological Instruments* by W.E.K. Middleton and A.F. Spilhaus., University of Toronto, Canada.

**BIPMT 205 Remote Sensing and Satellite Meteorology****Remote Sensing**

- Multi-concept of RS
- Advantages & disadvantages of RS
- Applications of RS

**Electromagnetic Radiation**

- E.M. energy
- Energy interactions in the atmosphere & with Earth's surface
- Image resolution and Pixel & mixed pixel

**Sensors and Platforms**

- Broad classification of sensors & platforms
- Land observation satellites & platforms
- High resolution sensors
- EO-1
- Weather satellites,
- Marine observation satellite.



**Satellite Data products:**

- Data reception
- Transmission & processing
- RS data, data products
- Referencing scheme
- Standard products
- Digital data products
- Meteorological satellite data
- Introduction to MODIS

**Satellite Image interpretation**

- Interpretation procedure
- Elements of photo interpretation
- Image interpretation strategies
- photomorphic analysis
- Image interpretation keys
- Equipment for image interpretation
- Automated approach to image classification

**Digital image processing**

- Overview of digital analysis steps
- Initial statistics extraction
- Image rectification & restoration
- Image enhancement
- Spatial filtering
- Image transformations
- Image classification & analysis

**Applications of RS**

- Land-use & land-cover mapping
- Crop inventory studies
- Ground water mapping
- Urban growth studies
- Flood plain mapping
- Hydro morphological studies
- Wasteland mapping
- District level mapping
- Disaster management

**Books Recommended:**

- i) *Text book of R. S. & GIS* by M. Anji Reddy, BS Publications, Hyderabad, India.
- ii) *Introduction to R. S.* by Arthur P. Cracknell and Ladson Hayes, CRC Press, USA.
- iii) *R. S. & GIS* by A.M. Chandra and S.K. Ghosh, narosha Publication House, India.
- iv) *Fundamentals of GIS* by Chakraborty D., Viva Books, New Dehli, India.
- v) *R.S. & Image Interpretation* by Thomson Lillesnd., John Wiley & Sons, Haryana, India.

## **BIPMT 206 Observations and Tabulation**

### **Part – I Surface Observations (Instrumental & Non-Instrumental Observations)**

(Alongwith Pocket Register)

- Reading
- Calculation
- Conversion and Correction of different meteorological parameters
- Entering in Pocket registers

### **Part – II Tabulation of Data**

- MMR (Monthly Meteorological Register)
- ACWR (Aviation Current Weather Register)
- Tabulation of Upper Winds
- Monthly Upper Air Register
- Different Monthly Statements

## **BIPMT 207 Codes**

### **Part–I Surface Codes**

- Synoptic Codes
- Aviation Codes

### **Part–II Upper Air Codes**

- Pilot Codes
- Temps Codes

### **Table Driven Code Form**

#### ***Books Recommended:***

- i) **Surface Weather Code** by Pak Met Department 1995 to 2008
- ii) **Ship Code** by Pakistan Meteorological Department
- iii) **Pilot Code** by Pakistan Meteorological Department 1995 to 2005
- iv) **Temp Code** by Pakistan Meteorological Department 1995 to 2005
- v) **Neph Code** by Pakistan Meteorological Department 1995 to 2005
- vi) **Aeronautical Code** by Pakistan Meteorological Department 1996

## **BIPMT 208 Plotting**

- Surface Observation Plotting
- Upper Air Observation Plotting
  - i) Pilot
  - ii) Temps
- Introduction to Computer based Plotting

## **BIPMT 209 Aeronautical Meteorology**

- Aviation Hazardous phenomena
- Meteorological Aspects of Flight Planning
- Definition of Aviation terms
- Air Traffic Services
- Aeronautical Telecommunication
- Procedure for Meteorological Services for International Aviation
- WMO documents
- ICAO documents

### ***Books Recommended:***

- i) ***Handbook of Aviation Meteorology*** by Her Majesty's Stationary office, London 1960
- ii) ***International Standard and Recommended Practices***. Meteorological Series for International Air Navigation Annex-3. (11<sup>th</sup> Edition)., International Civil Aviation Organization.

## **BIPMT 210 Computer Practice**

### **Programming language ForTran**

- Structure of ForTran
- Commands
- Statements
- Functions
- Operators

### **Designing applications using ForTran**

- Designing applications for generating
  - i) Synop
  - ii) Metar
  - iii) Pocket Register for data storage.

### **Computing through ForTran**

- Computing thermo-dynamical & meteorological laws using ForTran.

### **MS-Excel**

Data-import and statistical processing, Organizing data, Drawing different products.

### **ETo Calculator**

Making CXT files, Application of ETo calculator

### ***Books Recommended:***

- i) ***Fortran Reference Manual*** by Microsoft Corporation
- ii) ***Fortran for the 90s problem solving for Scientists and Engineers*** by Stacey L. Edgar.
- iii) ***Programming with Fortran***, by Seymour Lipschutz and Arthur Poe, McGraw-Hill, USA, Schaum's Outline Series.

## **BIPMT 211 Upper Air Observations**

### **Pilot Balloon Observation**

- Introduction
- Setting of theodolite
- Computation
- Ascent with and without tail
- Night ascent
- Selection of balloon and preparation
- Preparation of coded messages

### **Temps Observation**

#### ***Books Recommended:***

- i) *The measurement of Upper Winds* by Means of Pilot Balloon, H.M.S. Office, London.
- ii) *Handbook of Met. Instruments* part-II, H.M.S. Office London, M.O.557. 1956
- iii) *Technical Instruction for Pilot Balloon Station* by Pakistan Meteorological Department. 1961

## Basic Instruction Package for Meteorologists

### BIP-M (Middle Level)

#### Basic Forecasting Course (32 weeks duration)

S.No.	Course No.	Particulars / Subject	Credit
1.	BIPM 301	Dynamic Meteorology	3 + 0
2.	BIPM 302	Physical Meteorology & Atmospheric Thermodynamics	4 + 0
3.	BIPM 303	Synoptic Meteorology	3 + 0
4.	BIPM 304	Synoptic Meteorology Practicum	0 + 6
5.	BIPM 305	Aeronautical Meteorology	1 + 0
6.	BIPM 306	Tropical Meteorology	1 + 0
7.	BIPM 307	Climatology	2 + 0
8.	BIPM 308	Remote Sensing & GIS	1 + 2
9.	BIPM 309	Computer Programming	1 + 2
10.	BIPM 310	Hydrometeorology	2 + 0
11.	BIPM 311	Research Project	0 + 2

Examination ..... 2 weeks  
 On-Job-Training ..... 20 weeks

## **BIPMT 301 Dynamic Meteorology**

### **Derivation the basic equations**

- Vectorial form of the equation of motion in rotating coordinate system
- Fundamental forces of pressure and gravitation
- Centripetal and coriolis forces
- The equation of motion (cartesian, spherical and natural coordinates)
- Scale analysis of the equations of motion
- The equations of motion with pressure as vertical coordinate
- The continuity equation
- Divergence and vertical motion

### **Balanced horizontal flow:**

- Geostrophic flow
- Inertial flow
- Gradient flow and cyclostrophic flow
- Trajectories and streamlines
- Geostrophic thermal wind

### **Circulation and vorticity**

- Stokes theorem
- Bjerkne's circulation theorem
- Vorticity equation
- Scale analysis of the vorticity equation
- The barotropic vorticity equation
- Constant absolute vorticity trajectory
- Rossby waves

### **The planetary boundary layer**

- Description of flow near a boundary;
- The mixing length theory;
- Velocity profiles ear the boundary;
- The Ekman layer. Introduction to numerical weather prediction;
- Physical basis of numerical weather prediction;
- Types of atmospheric models,
- Elements of numerical solutions to the equations of motion:
- Finite differences.

### **Books Recommended:**

- i) *Compendium of Meteorology* for use by Class I & II Meteorology Personnel by Aksel Wiin-Nielson, WMO No. 364, Volume-I, Part-I, Dynamic Met. Geneva, Switzerland. 1973
- ii) *An Introduction to Dynamic Meteorology* by James Holton, J.R. *An Introduction to Dynamic Meteorology*, (3<sup>rd</sup> edition). Academic Press Inc. Harcourt Brace Jovanovicit Publishers, London. 1992
- iii) *Dynamic & Physical Meteorology* by Haltiner, G.J., & F.L.Martin. *Dynamic & Physical Meteorology*. McGraw Hill Book Co. Inc., New York, USA. 1957
- iv) *Elements of Dynamic Met.* by A.H. Gordon., The English University Press Ltd., New gate Street, London.

- v) *Dynamic Meteorology* by Bernhard Hauriotz, Ph.D., McGraw Hill Book Company Inc., New York and London.
- vi) *Numerical Prediction & Dynamic Met.* by G.J.Haltiner & R.T. Williams (Second Edition), John Wiley Publication, New York, USA.

## **BIPMT 302 Atmospheric Thermodynamics & Physical Meteorology**

### **Review of fundamental concepts of thermodynamics**

- Temperature
- Work
- Equation of state
- First law of thermodynamics and enthalpy
- Adiabatic processes and potential temperature
- The second law of thermodynamics
- Entropy

### **Thermodynamics of water vapour and moist air**

- Thermodynamic properties of water
- Phase transition of water
- Water vapour and moist air
- Clausius-Clapeyron's equation

### **Aerological diagrams**

- Selection of coordinates
- Clapeyron diagram
- Struve diagram
- Emmagram
- Tephigram
- Skew-T-log $\theta$  diagram
- Choice of diagram

### **Atmospheric statics**

- The hydrostatic equation;
- Integration of the hydrostatics equation for homogeneous, isothermal, dry adiabatic & standard atmospheres;
- Computation of geopotential heights from upper air soundings.

### **Radiation:**

- Radiation laws
- Reflection, diffusion, scattering and absorption of solar radiation
- Terrestrial radiation
- Heat balance of the earth atmosphere system

### **Cloud and precipitation**

- Condensation and growth of water droplets
- Precipitation processes
- Some aspects of artificial stimulation of precipitation and hail suppression

**Vertical stability**

- Parcel method
- The Brunt Vaisala frequency
- Stability criteria
- Lapse rates
- Conditional instability
- Layer method of instability analysis
- Calculation of perceptible water and precipitation rates

**Books Recommended:**

- i) ***Dynamic and Physical Meteorology*** by Haltiner, G.J., and F.L., Martin. McGraw Hill Book Company Inc, New York, USA. 1957
- ii) ***Cloud Atmosphere*** by R.R. Rogers & M.K. Yau., 3<sup>rd</sup> edition., Elsevier Science, Oxford, U.K.
- iii) ***The Atmosphere : An Introduction to Meteorology*** by Frederick K. Lutgens and Tarbuck Edward J, 9<sup>th</sup> Edition, Prentice Hall, Upper Saddle River, New Jersey 07458. 2012
- iv) ***Compendium of Meteorology*** by B.J. Retallac. Meteorology, WMO NO.364, Volume-I, Part-II, Physical Met. Geneva, Switzerland. 1973
- v) ***Physical Meteorology*** by Jhon C. Johnson., The Massachusetts Institute of Technology, USA. 1954
- vi) ***Atmospheric Thermodynamic*** by Iribarne, J.V. and Godson W.L., Kluwer Academic Publisher. 1981
- vii) ***Introduction to Theoretical Meteorology*** by Hess S.L., Holt, Rinehart and Winston. *Introduction to Theoretical Meteorology*, Henry Holt and Company, New York.
- viii) ***A short course in Cloud Physics*** by Rogers R.R. and Yau M.K., Pergamon Press.

**BIPMT 303 Synoptic Meteorology****Air masses**

- Their source regions
- Characteristic
- Classification

**Frontal surface and frontal zones**

- Associated frontal weather and flow pattern
- Frontal disturbances
- Kinematics of frontogenesis

**Jet Streams**

- Westerly Jet Stream
- Easterly Jet Stream

**Upper air flow patterns**

- The general circulation
- Mean seasonal flow and pressure patterns
- Elements of surface and upper air analysis in low latitudes

**Monsoon and Tropical disturbances**

- Land & Water differential heating
- Formation of depressions and Tropical Cyclones
- Impact of IOD, MJO, ENSO, AO, NAO on summer monsoon



- Recent changes in flow pattern of summer Monsoon
- Effect of TP, HKH and heat low on summer monsoon

#### **Aviation hazards and their association with synoptic patterns**

- Aircraft icing
  - Turbulence
  - Fog
  - Thunderstorms
  - Dust storms
  - Low-level vertical wind shear
  - Meteorological aspects of flight planning
- 
- Use of satellites in synoptic analysis
  - The problem of synoptic weather forecasting
  - Forecasting techniques
  - The use of numerical weather prediction products in synoptic forecasting

#### **Books Recommended:**

- Introduction to Meteorology* by Petterssen, S. McGraw Hill Book Company, New York, USA. 1958
- Compendium of Met.* for use by Class I & II Meteorological Personnel, by DeJant W.H.T.Morth, volume I, Part-3, Synoptic Meteorology, WMO No.364., Geneva, Switzerland. 1973
- The Meteorology of Pakistan* by K.M.Shamshad., Pakistan Meteorological Deptt. 1988

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### **BIPMT 304 Synoptic Meteorology Practicum**

- Reviews of basic analysis techniques
- Isobaric analysis of surface charts
- Frontal analysis
- Analysis of isobaric surfaces
- Temperature and moisture analysis
- Isallobaric analysis
- Differential analysis
- Streamlines isotach analysis
- Time cross-sections
- Aerological cross-sections
- Hodograph analysis
- T-Ø gram analysis
- Preparation of prognostic charts
- Preparation or route forecast folder for aviation
- Computer based Analysis

#### **Books Recommended:**

- Principles of Meteorology Analysis* by Saucier, W.J., *Principles of Meteorological Analysis*. University of Chicago Press, Chicago, USA.

## **BIPMT 305 Aeronautical Meteorology**

- Aircraft Icing
- Turbulence
- Other hazardous phenomena
- Meteorological aspects of flight planning
- Definitions
- Procedures for meteorological services for international air navigation
- Air traffic services
- Aerodromes
- Operation of aircraft
- Aeronautical information services
- Aeronautical telecommunications
- WMO documentation
- ICAO documentation

### ***Books Recommended:***

- i) ***Compendium of Meteorology*** for use by Class I & II Met Personnel by RetallacB.J., *Compendium of Meteorology*, Volume-I, Part-II, Physical Meteorology. WMO NO.364. Geneva, Switzerland. 1973
- ii) ***Handbook of Aviation Meteorology*** by Her Majesty's, Stationary office, London. 1960
- iii) ***International Standard and Recommended Practices***. Meteorological Series for International Air Navigation Annex-3 (11<sup>th</sup> Edition), International Civil Aviation Organization.

## **BIPMT 306 Tropical Meteorology**

### **Introduction**

- Difference between tropical meteorology & mid-latitude meteorology.
- Tropical general circulation.

### **Pressure Patterns**

- Winter pressure patterns
- Summer pressure patterns

### **Intra Tropical Convergence Zone**

- In winter
- In summer

### **Airmasses**

- Tropical Maritime
- Tropical Continental
- Equatorial

### **Monsoons**

- Winter Monsoon
- Summer Monsoon
- Land & Water differential heating
- Formation of depressions and Tropical Cyclones

- Impact of IOD, MJO, ENSO, AO, NAO on summer monsoon
- Recent changes in flow pattern of summer Monsoon
- Effect of TP, HKH and heat low on summer monsoon

### **Weather Producing Systems**

- Winter (Western disturbance, Orographic influence, Nor'westers, NE Monsoon)
- Summer (Monsoon Lows/depressions, Mid-troposphere lows, Westerly Waves, Orographic Influence, Dust-devils, Dry line)
- Convective weather producing systems
- Formation and build up of Cloud Burst events.

### **Easterly Waves**

- Low level Easterlies and their impact on regional weather
- Equatorial easterlies and IOD, MJO, ENSO pattern

### **Tropical Storms**

- Tropical Depressions
- Tropical Cyclones

### **Books Recommended:**

- i) ***Tropical Meteorology*** by Toby N. Carlson, Department of Meteorology, The Pennsylvania State University, Part-I & II, Meteo 452. 1979
- ii) ***Compendium of Meteorology*** for use by Class I & Class II Met Personnel by Aksel Wiin Nielsen, Volume-II, Part 4, Tropical Meteorology 1979
- iii) ***Symposium on Monsoon of the World*** by India Met Department 1958
- iv) ***The WMO/IMD Training Course in Monsoon Meteorology***, by volume I & II.
- v) ***The Meteorology of Pakistan*** by K.M. Shamshad., Pak Met. Dept. 1988

### **BIPMT 307 Climatology**

- Review of general climatology
- Astronomical and geographical factors
- Climatic elements
- World climate classification
- Climates of Asia
- Climates of the sub-continent
- Climatological statistics
- Mean, mode, median, deviations trends
- Introduction to time series analysis
- Extreme-value analysis
- Global Warming & Climate Change
- Natural & Anthropogenic reasons of Climate Change
- Global & Pakistan perspective
- Climate change assessment
- Impact of climate change on water, agriculture & weather pattern

### **Books Recommended:**

- i) ***Fundamentals of Physical Geography*** by David Briggs and Peter Smithson.
- ii) ***An Introduction to Climate*** by Trewartha, G.T. *An Introduction to Climate*. McGraw Hill Book Company Inc., New York, USA.

- iii) *Climatology* by Haurwitz, B. and James M. Austin,. *Climatology*. McGraw Hill Book Company Inc., New York, USA.
- iv) *Physics of the Climate* by Jose P. Peixoto, MIT, USA
- v) *Statistics* by Frank Ayres,G.R.*Statistics*, Schaum's Outline Series, NewYork, USA.
- vi) *Introduction to Statistical Theory* by Choudhry .S. M.,Ilmi Kitab Khana, Urdu Bazar, Lahore.
- vii) *The Meteorology of Pakistan* by K.M. Shamshad, Pak Met. Dept. 1988

## **BIPMT 308 Remote Sensing and GIS**

### **GIS Practical usage Techniques:**

Cartography & Projections, ArcScan, Data Interoperability Geocoding, Geodatabases, Geoprocessing, Geospatial Analysis, Linear Referencing, Maplex, Network Analysis, Schematic Designing, 3D Analysis, Map Publishing, Spatial Analysis, Survey Analysis, Tracking Tools.

### **ERDAS Imaging :**

Image Processing, Modelling

### **ENVI :**

Image processing of different Satellite Databases

### **Quantum GIS :**

Hydrology Applications

### **ArcView :**

Hydrology Applications

### **Books Recommended:**

- (i) *GIS Tutorial 1 Basic Workbook* by Wilpen L. Gorr and Kristen S. Kurland. Fourth Edition.
- (ii) *GIS Tutorial 2 Spatial Analysis Worknook* by David W. Allen. Second Edition.
- (iii) *GIS Tutorial 3Advanced Workbook* by David W. Allen & Jeffery M. Coffey.
- (iv) *Fundamentals of ERDAS IMAGINE I – Manual & Data*
- (v) *Fundamentals of ERDAS IMAGINE II – Manual & Data*
- (vi) *Image Analysis for ArcGIS – Manual & Data*
- (vii) *Stereo Analysis for ArcGIS – Manual & Data*

## **BIPMT 309 Computer Programming**

### **Programming language ForTran**

- Structure of ForTran
- Commands
- Statements
- Functions
- Operators

- Arrays
- Filing
- Practice

### **Computing through ForTran**

- Computing thermo-dynamical & meteorological laws using ForTran.

### **Designing applications using ForTran**

- Designing applications for generating  
     Synop  
     Metar  
     TÓ-gram  
     Pocket Register for data storage.

### **Linux OS, Basic & Advance:**

- Installation & general commands
- administration of different types of Servers in Linux

### **Introduction of some useful software**

- GRADS
- Surfer

### **Books Recommended:**

*Fortran Reference Manual* by Microsoft Corporation

*Fortran for the 90s problem solving for Scientists and Engineers* by Stacey L. Edgar.

*Programming with Fortran*, by Seymour Lipschutz and Arthus Poe, McGraw-Hill, USA, Schaum's Outline Series.

*Red Hat Linux Server 5, End-User Reference Manual* by Pakistan Computer Bureau.

*Red Hat Linux Server 5, System Administrator Manual* by Pakistan Computer Bureau

### **BIPM 310 Hydrometeorology**

- The hydrological cycle
- Precipitation amount, intensity, duration and distribution
- Evaporation and evapotranspiration
- Infiltration and soil moisture
- Surface run-off
- Groundwater
- Water balance
- Hygrometry
- Elements of flood forecasting

**Postgraduate Diploma in Meteorology (36 weeks duration)**  
**( Grading system is as followed in B.S / degree program )**

**Meteorology Courses (Part-I), duration 18 weeks**

<i>Course No.</i>	<i>S u b j e c t</i>	<i>Credit</i>
PGD (Met.) 411	Synoptic and Tropical Meteorology	3+0
PGD (Met.) 413	Elements of Earth Science	3+0
PGD (Met.) 415	Dynamic Meteorology	3+0
PGD (Met.) 417	Introduction to Computer Systems	2+1
PGD (Met.) 419	Meteorological Practices	1+1
PGD (Met.) 44x	Elective Topic	1+0
<b>Total Credit Hours</b>		15

**Meteorology Courses (Part-II), duration 18 weeks**

<i>Course No.</i>	<i>S u b j e c t</i>	<i>Credit</i>
PGD (Met.) 422	Atmospheric Thermodynamics	3+0
PGD (Met.) 424	Physical Meteorology	3+0
PGD (Met.) 426	Climatology	3+0
PGD (Met.) 428	Aviation Meteorology	2+1
PGD (Met.) 430	Synoptic Meteorology Practical and Forecasting Practices	0+1
PGD (Met.) 432	Research Project	1+0 or 0+1
PGD (Met.) 44x	Elective Topic	1+0
<b>Total Credit Hours</b>		15

**Elective Subjects (1credit hour each semester; offered subject to arrangement)**

<i>Course No.</i>	<i>Elective S u b j e c t</i>	<i>Credit</i>
PGD (Met.) 441	General Hydrology	1
PGD (Met.) 442	Seismology and Geomagnetism	1
PGD (Met.) 443	Air Pollution Meteorology	1
PGD (Met.) 444	Satellite Meteorology	1
PGD (Met.) 445	Marine Meteorology	1
PGD (Met.) 446	Numerical Weather Prediction	1
PGD (Met.) 447	Space Science	1

**(PART-I)****PGD (Met.) 411 Synoptic & Tropical Meteorology****Synoptic Meteorology**

- Composition and structure of the atmosphere
- Weather elements
- Pressure patterns
- Atmospheric motion systems
- General circulation and forces
- Air masses
- Frontal systems

***Books Recommended:***

- i) *Meteorology*. by Anthes, R.A., 7<sup>th</sup> edition, Prentice Hall, New Jersey, US.
- ii) *The Atmosphere : An Introduction to Meteorology*, by Lutgens, F.K., and E.F. Tarbuck, 9<sup>th</sup> edition., The Prentice Hall, New Jersey, USA.

**Tropical Meteorology**

- Tropical general circulation,
- Low-latitude weather disturbances,
- Monsoons,
- Tropical cyclones.

***Books Recommended:***

- i) *Weather and Climate*, by Agudo, E., and J.E. Burt, (3<sup>rd</sup> edition), The Prentice Hall, New Jersey, USA.[*Atmospheric Physics, Weather, Climatology*]
- ii) *Global Climatology*. (Springer-Verlag, Berlin) by Rodo Xavier, Francisco,A. Comin,.
- iii) *Advances in Tropical Meteorology*. Concept Publishing Company, New Delhi, India.
- iv) *Training Course in Monsoon Meteorology*, WMO., Volume I & II, WMO No. 496, Geneva, Switzerland.

**PGD (Met.) 413 : Elements of Earth Science****Elements of Earth Science**

- Earth and solar system,
- Kepler's laws of planetary motion,
- Newton's law of universal gravitation,
- The Sun and its electromagnetic spectrum, map projections,
- Description of the various map projections,
- Practical problems

**Books Recommended:**

- i) *Geosystems: An Introduction to Physical Geography* by Christopherson, Robert, W. Printice Hall Inc., Englewood Cliffs N.J.,USA.
- ii) *The Earth's Dynamic Systems – A Textbook in Physical Geology* by Hamblin, W. Kenneth. Macmillan Publication, USA.
- iii) *Environmental and Engineering Geophysics* by Sharma, P.V. Cambridge University Press, New York, USA.

**PGD (Met.) 415 Dynamic Meteorology****Dynamic Meteorology**

- Basic equations of motion in rotating coordinate system,
- Fundamental forces of pressure and gravitation,
- The continuity equation,
- Divergence and vertical motion,
- Circulation and vorticity,
- Scale analysis of the vorticity equation.

**Books Recommended:**

- i) *Ceaseless Wind: An Introduction to the Theory of Atmospheric Motion* by Dutton, J.A. McGraw Hill Book Company Inc., New York, USA.
- ii) *An Introduction to Dynamic Meteorology*, by Holton, J.R. 3<sup>rd</sup> edition Academic Press Inc., San Diego, California, USA.
- iii) *Compendium of Meteorology for use by Class I & II Meteorology Personnel*, by Wiin-Nielson, A.C., Volume-I, Part-I, Dynamic Meteorology. WMO No. 364., Geneva, Switzerland.

**PGD (Met.) 417: Introduction to Computer System****Introduction to Computer System**

- i) Introduction to computers, operating systems,
- ii) DOS,
- iii) Windows 95/98,
- iv) networking and data communication,
- v) introduction to programming languages,
- vi) programming exercises,
- vii) hands-on practice on Windows,
- viii) e-mail sending/receiving, searching,
- ix) downloading, etc., MS-Word 2000,
- x) MS-Excel 2000, MS-Access 2000 etc.

**Books Recommended:**

- i) *Structured FORTRAN 77 for Engineers and Scientists* by Etter, D. M. Benjamin / Cummings Publishing Company, New York, USA.



- ii) *DOS User's Guide and Reference Manual* by IBM Corporation. B.M., North Harbour, Portsmouth, U.K.
- iii) *Windows User's Guide* by Microsoft, Microsoft Corporation, North Harbour, Portsmouth, U.K.
- iv) *A Fundamental Course of Computer* by Sohail M. Pakistan Meteorological Department, IMG, Karachi, Pakistan.
- v) *The C++ Programming Language* by Stroustrup, B., 3<sup>rd</sup> edition, Addison Wesley Longman Inch., Murray Hill, New Jersey, USA.

## PGD (Met.) 419 : Meteorological Practices

### Meteorological Instruments and Observations

- Construction and maintenance of various meteorological instruments,
- Introduction to radiosonde equipments,
- Wind finding radar,
- Weather surveillance radar,
- Methods of observations,
- Meteorological codes,
- Tabulation and compilation of met data.

### Books Recommended:

- i) *Weather Watching* by Burroughs, W.J., B.Crowder, T. Robertson, E.V. Talbot, R.Whitaker. Fog City Press, San Francisco,USA.
- ii) *Code Books* by P.M.D, latest edition, Pakistan Meteorological Department, Karachi, Pakistan.
- iii) *Hands on Meteorology* by Sorbjan and Zbigniew. American Meteorological Society, Boston, USA.
- iv) *Guide to Met. Instruments and Methods of Observation*, WMO No. 8, W.M.O. Geneva, Switzerland.

### Plotting and Analysis of Weather Maps and Charts

- Index number,
- Symbols for various weather phenomena,
- Plotting of various meteorological charts,
- Weather map analysis,
- Contour analysis,
- Isobaric analysis,
- Frontal analysis,
- Streamline-isotach analysis

### Books Recommended:

- i) *Atmospheric Data Analysis* by Daley, R. Cambridge University Press, London, U.K.
- ii) *Interpretation and Analysis of Weather Maps.* by Khan, J.A. Karachi University Press, Karachi, Pakistan

**PGD (Met.) 44X : ELECTIVE TOPIC (offered by pre-arrangement)**

- One topic may be chosen from Course No. IMG 441 – 447 for Part-I and another topic for Part-II and topic so chosen cannot be repeated.

**(PART-II)**

**PGD (Met.) 422 Atmospheric Thermodynamics**

**Atmospheric Thermodynamics**

- Fundamental concepts of thermodynamics,
- Thermodynamic properties of the water substance,
- Phase transition of water,
- Water vapour and moist air,
- Analysis of tephigram,
- Practical work.

***Books Recommended:***

- Weather Watching* by Burroughs, W.J., B.Crowder, T. Robertson, E.V. Talbot, R. Whitaker. Fog City Press, San Francisco, USA.
- Atmospheric Thermodynamics* by Godson., W.L., and J.V. Iribarne. Kluwer Academic Publisher, London, U.K.
- The Atmosphere : An Introduction to Meteorology* by Lutgens, F.K., and E.F. Tarbuck., 9<sup>th</sup> edition., The Prentice Hall, New Jersey, USA.
- A short course in Cloud Physics* by Rogers, R. R. and M. K. Yau. Pergamon Press, Oxford, London, U.K.

**PGD (Met.) 424 Physical Meteorology**

**Physical Meteorology**

- The electromagnetic spectrum,
- Radiation laws,
- Terrestrial radiation through the atmosphere,
- Heat balance of the earth atmosphere system,
- Cloud and precipitation,
- Some aspects of artificial stimulation of precipitation and hail suppression

***Books Recommended:***

- The Physics of the Atmosphere* by Houghton, J., 3<sup>rd</sup> edition, Cambridge University Press, London, U.K.
- Physical Meteorology* by Johnson, J.C. Massachusetts Institute of Technology, Cambridge, Massachusetts, USA.
- The Atmosphere: An Introduction to Meteorology* by Lutgens, F.K., and Edward J. Tarbuck. McGraw Hill Book Company Inc., New York, USA.

- iv) *Compendium of Meteorology* by Retallac, B.J., Volume-I, Part-II, Physical Meteorology. WMO NO.364, Geneva, Switzerland.

## **PGD (Met.) 426 Climatology**

### **Climatology**

- Review of general climatology,
- Principles of climate classification,
- World climate classification,
- Climates of Asia,
- Climates of the sub-continent,
- The climate of Pakistan,
- Climate change,
- Use of standard computerized statistical packages in climatological data processing

### **Books Recommended:**

- i) *Understanding Weather and Climate* by Aguado, E. and James Burt, 2003. Prentice Hall Inc., Englewood Cliffs N.J., USA.
- ii) *General Climatology* by Critchfield, H. J. 4<sup>th</sup> edition., Prentice Hall Inc., Englewood Cliffs N.J., USA.
- iii) *The Climate of Pakistan* by Khan, J.A. Rehbar Publisher, Karachi, Pakistan.
- iv) *Physics of the Climate* by Peixoto, J. P. MIT Press, Massachusetts, USA.
- v) *Introduction to Physical Geography* by Scott, R.C. West Publisher Company, New York, USA.
- vi) *The Meteorology of Pakistan* by Shamshad, K.M. Royal Book Company, Karachi, Pakistan.
- vii) *Atmosphere, Weather, and Climate* by Sidhartha, K. Kisalayana Publications Pvt. Ltd., New Delhi, India.
- viii) *Statistical Analysis in Climate Research* by von Storch Hans, Francis W. Zwiers. Cambridge University Press, Cambridge, U.K.

## **PGD (Met.) 428 Aviation Meteorology**

### **Aviation Meteorology**

- Definition of aviation terms
- Procedures for meteorological services for air navigation
- Air traffic services
- Aerodrome requirements and operations
  
- Meteorological requirement of aircraft operations
- Meteorological briefings
- Meteorological aspects of flight planning
- Aeronautical communications
- Aviation hazards and their association with synoptic patterns, aircraft icing, turbulence, fog, thunderstorms, dust storms, low-level vertical wind shear.

**Books Recommended:**

- i) *Weather Watching* by Burroughs, W.J., B.Crowder, T. Robertson, E.V. Talbot, R. Whitaker. Fog City Press, San Francisco, USA.
- ii) *The Atmosphere : An Introduction to Meteorology*, by Lutgens, F.K., and E.F. Tarbuck., 9<sup>th</sup> edition., The Prentice Hall, New Jersey, USA.
- iii) *Compendium of Meteorology for use by Class I & II Meteorological Personnel* by Retallack, B. J., Vol-II, Part-II – Aeronautical Meteorology. WMO No. 364, Geneva, Switzerland.

**PGD (Met.) 430 Synoptic Meteorology Practical and Forecasting Practices****Synoptic Meteorology Practical and Forecasting Practices**

- Analysis of surface and upper air charts
- Differential analysis, time cross-sections
- Aerological cross-sections
- Hodograph analysis
- T-Ø gram analysis
- Use of satellites in synoptic analysis
- Preparation of prognostic charts
- Preparation of route forecast folder for aviation

**Books Recommended:**

- i) *Atmospheric Data Analysis* by Daley, R. Cambridge University Press, New York, USA.
- ii) *Forecast Verification: A Practitioner's Guide in Atmospheric Science* by Jolliffe, L.T., and David B. Stephenson. John Wiley and Sons, Inc., New York, USA.
- iii) *Principles of Meteorological Analysis* by Saucier, W.J.,1. University of Chicago Press, Chicago, USA.

**PGD (Met.) 432 Research Project****Research Project**

Students of Meteorology Course Part-II are required to write a research paper on a topic to be chosen by the students in consultation with the research supervisor. The completed reports are to be submitted immediately after the end of theory classes of last term of Part-II, so that a suitable date for its presentation be given to each student.

**PGD (Met.) 44X ELECTIVE TOPIC (offered by pre-arrangement)****PGD (Met.) 441 General Hydrology****General Hydrology**

- Introduction to hydrology
- Outlines and components of the hydrological cycle
- Precipitation, measurement and rainfall analysis

- Evaporation and evapotranspiration
- Groundwater
- Water balance
- Water quality
- Elements of flood forecasting

**Books Recommended:**

- i) *Hydrology and Soil Conservation Engineering* by Das Ghanshyam. Prentice Hall, India.
- ii) *Geoenvironmental Hazards in Himalaya* by Pandey Bindhy Wasini. Mittal, Publications, New Delhi, India.
- iii) *Research Basins and Hydrological Planning* by Ru-Ze Xi, Wel-Zu Gu, and Klaus Peter Seiler. A.A. Balkema Publishers.
- iv) *Cold Climate Hydrometeorology* by Upadhyay, D.S. John Wiley and Sons, Inc., New York, USA
- v) *Guide to Hydrological Practices.* by WMO, WMO No. 168, TP-82. Geneva, Switzerland.

**PGD (Met.) 442 Seismology and Geomagnetism**

**Seismology**

- General seismology
- Wave equation
- Elasticity and elastic waves
- Physical geology
- Plate tectonics
- Earthquakes
- Earthquake intensities
- Effect of earthquakes
- Travel time curve
- Earthquake belts and distribution of earthquakes in Pakistan

**Geomagnetism**

- Introduction to geomagnetism
- Geomagnetic elements
- External magnetic field
- Rock magnetism
- Palaeo-magnetism
- Rock magnetism properties
- Magnetic induction
- Susceptibility
- Flux
- Thermo-remnant and natural remnant magnetization
- Geomagnetic prospecting
- Principle of ground magnetic surveys
- Single pole deposits

- Doublets and dikes

**Books Recommended:**

- i) *Weather Watching* by Burroughs, W.J., B.Crowder, T. Robertson, E.V. Talbot, R.Whitaker. Fog City Press, San Francisco, USA.
- ii) *Geomagnetism* by Chapman, S. and Bartels, Volume I and II . Oxford University Press, London, U.K.
- iii) *Introduction to Geophysics* by Howell Jr., B.F., McGraw Hill Book Company Inc., New York, USA.
- iv) *An Introduction to Geophysical Exploraton* by Kearey, P., and Brooks, M. 2<sup>nd</sup> edition., Blackwell Scientific Publication, London, Edinburgh, Boston.
- v) *Geoenvironmental Hazards in Himalaya* by Pandey Bindhy Wasini. Mittal Publications, New Delhi, India.
- vi) *Elementary Seismology* by Richter, C. F. W.H. Freeman and Company, San Francisco, USA.

**PGD (Met.) 443 Air Pollution Meteorology**

**Air Pollution Meteorology**

- Turbulence in the atmospheric boundary layer
- Diffusion theory and experiments
- The Gaussian-plume rise due to momentum and buoyancy
- Estimation of diffusion parameters from meteorological data
- Dispersion of pollutants
- Case studies and practical exercise

**Books Recommended:**

- i) *Air Pollution Analysis* by Harrison, R., and Rojer Perry. Capman and Hall, New York, USA.
- ii) *Atmospheric Pollution* by Jacobson, M. Z. John Wiley and Sons Inc., New York, USA.
- iii) *Compendium of Meteorology*, Air Chemistry & Air Pollution Meteorology, by Rodhe, H., and R.E. Munn, Volume II, Part VI . WMO No.364, Geneva, Switzerland.

**PGD (Met.) 444 Satellite Meteorology**

**Satellite Meteorology**

- Introduction to satellites
- Principles of remote sensing
- Types of sensors
- Remote sensing platforms
- Satellite data interpretation

**Books Recommended:**

- i) *Rainfall Prediction using Satellite Data* by Barrett and Curtis. Edward Arnold, London, U.K.

- ii) *Introductory Remote Sensing*, *Principles and Concepts* by Gibson, R. Routledge, London, U.K.
- iii) *Remote Sensing and Image Interpretation* by Lillesand, T.M. and Ralph W. Kiefer. John Wiley and Sons Inc., New York, USA.
- iv) *Satellite Systems, Principles and Technologies* by Paltan, B. Van Nostrand Reinhold, New York, USA.

## PGD (Met.) 445 Marine Meteorology

### Marine Meteorology

- Physical properties of sea water
- Dynamics of the upper ocean
- Heat balance of the ocean
- Air-sea interaction
- Water-masses
- Oceanic fronts and thermoclines
- Sea waves, swells
- Tsunamis and storm surges, marine meteorological services

### Books Recommended:

- i) *The Sea: The Global Coastal Ocean* by Brink, K. H., and Allan R. Robinson. John Wiley and Sons Inc., New York, USA.
- ii) *Weather Watching* by Burroughs, W.J., B.Crowder, T. Robertson, E.V. Talbot, R. Whitaker. Fog City Press, San Francisco, USA.
- iii) *Marine Meteorology , Compendium of Meteorology*, by Fortheringham, R.R., Volume II, Part III. WMO No. 364, Geneva, Switzerland.
- iv) *The Waters of the Sea* by Groen, P. D. Van Nostrand Company, London, U.K.
- v) *Atmosphere – Ocean Dynamics* by Gill, A. E. Academic Press, New York, USA.
- vi) *The Atmosphere : An Introduction to Meteorology* by Lutgens, F.K., and E.F. Tarbuck., 9<sup>th</sup> edition. The Prentice Hall, New Jersey, USA.
- vii) *Notes in Marine Meteorology, for Class III and IV personnel* by Dr. Mertins, H.O. Notes in Marine Meteorology, for Class III and IV. WMO No. 434, Geneva, Switzerland.
- viii) *Notes in Marine Meteorology, for Class III and IV* by Dr. Mertins, H.O., WMO No. 434, Geneva, Switzerland.
- ix) *General Circulation Model Development* by Randall David A. Academic Press, USA.

## PGD (Met.) 446 Numerical Weather Prediction

### Numerical Weather Prediction

- Overview of numerical weather prediction operation
- Numerical methods
- Finite differencing, truncation errors
- Interpolation and data filtering
- Atmospheric models
- Filtered barotropic model

- Non-filtered models, baroclinic model, multi level models, practical exercises, uses of numerical products

**Books Recommended:**

- i) *The Ceaselen Wind: An Introduction to the Theory of Atmospheric Motion* by Dutton, J.A. Dover Publications, Inc., Mineola, New York, USA.
- ii) *Numerical Prediction & Dynamic Meteorology* by Haltiner, G.J., and R.T. Williams, . John Wiley Publication, New York, USA.
- iii) *Workbook on Numerical Weather for the Tropics, for the training of Class I & II Meteorological Personnel*, Krishnamurti T.N., WMO No. 669, Geneva, Switzerland.
- iv) *General Circulation Model Development* by Randall David A. Academic Press, USA.
- v) *Climate System Modeling* by Trenbreth. John Wiley and Sons Inc. New York, USA.
- vi) *Statistical Analysis in Climate Research* by von Storch Hans, Francis W. Zwiers. Cambridge University Press, Cambridge, U.K.

**PGD (Met.) 447 Space Science**

**Space Science**

- Introduction to space science
- Fundamentals of astronomy
- Solar-terrestrial physics
- Near-earth environment
- Satellite applications

**Books Recommended:**

- i) *Exploration: An Introduction to Astronomy* by Arny, T.T. Mosby – Year Book, Inc. Missouri, USA.
- ii) *Astronomy: The Cosmic Journey* by Hartmann, W.K. and C.Impey, . 5<sup>th</sup> edition., Wadsworth Publishing Company, Belmont, California, USA.
- iii) *Discovering the Universe* by Kaufmann, W.J. 4<sup>th</sup> edition W.H. Freeman and Company, New York, USA.
- iv) *Skywatching* by Levy, D.H. and J. O’Byrne, 1994. The Nature Company, New York, SA.
- v) *Text Bank for Press and Siever’s Understanding Earth* by Simon, M., and Peacock, . W.H. Freeman and Company, New York, USA.
- vi) *Global Observing System – Satellite Sub-system* by W.M.O. WMO No. 411, Geneva, Switzerland.



## Basic Instruction Package for Meteorologists

### BIP-M (Advance Level)

#### Advance Meteorology Course (One year duration)

S.No.	Course No.	Particulars / Subject	Credit
1.	BIPM 501	Dynamic Meteorology	2 + 0
2.	BIPM 502	Atmospheric Thermodynamics	2 + 0
3.	BIPM 503	Numerical Weather Prediction	1 + 1
4.	BIPM 504	Physical Meteorology	1 + 0
5.	BIPM 505	Synoptic Meteorology	3 + 0
6.	BIPM 506	Synoptic Meteorology Practicum	0 + 4
7.	BIPM 507	Climatology	2 + 0
8.	BIPM 508	Physical Oceanography	1 + 0
9.	BIPM 509	Air Pollution Meteorology	1 + 0
10.	BIPM 510	General Hydrology	1 + 0
11.	BIPM 511	Research	0 + 2

Examination ..... 2 weeks  
 Research ..... 12 weeks

## **BIPM 501 Dynamic Meteorology**

### **Formulation of the basic equations in vector and cartesian forms**

- Scale analysis of the equations of motion
- Applications of the equations to horizontal balanced flow
- Thermal wind;
- Generalized vertical coordinates.

### **Circulation and vorticity**

- Bjerkne's circulation theorem
- Vorticity equation and scale analysis of the vorticity equation
- Constant absolute vorticity trajectories
- Barotropic vorticity equation

### **Dynamic of synoptic scale disturbances**

- The quasi-geostrophic vorticity and thermodynamic equations
- Geopotential tendency equation;
- Omega equations;
- Pressure tendency equation;
- Atmospheric turbulence and diffusion:
- Nature and treatment of turbulent flow;
- Mixing-length hypothesis;
- Power-law profiles;
- Ekman layer;
- K-theory;
- Applications of heat flux problems.

### **Atmospheric wave motion**

- Acoustic waves
- Gravity waves
- Rossby waves
- External and internal gravity waves
- Inertia gravity waves
- Rossby-gravity waves
- Elementary treatment of barotropic and baroclinic stability

### **General circulation:**

- Momentum, heat and moisture budgets energetic of the general circulation.

### **Books Recommended:**

- i) *Compendium of Meteorology for Cass I & II Meteorological personnel* by Aksel Wiin-Nielson, Volue I, Part I, Dynamic Met., Geneva, Switzerland.
- ii) *An Introduction to Dynamic Meteorology* by John R. Holton (3<sup>rd</sup> edition)., McGraw Hill Book Company Inc., New York
- iii) *Dynamical & Physical Meteorology* by Haltiner, G.J., and F.L.Martin, McGraw Hill Book Company Inc., New York, USA.

## **BIPM 502 Atmospheric Thermodynamics**

### **Review of fundamental principles of thermostatics and thermodynamics**

- Formulation of the second law
- Reversible and irreversible transformations
- Thermodynamic potentials
- Gibb's equations

### **Thermodynamics systems in meteorology**

- Properties of dry and moist air
- Adiabatic transformation of dry and moist air
- Potential temperature
- Wet-bulb temperature
- Psychometric formula
- Equivalent temperature
- Wet bulb pseudo-potential temperature
- Dry and saturated adiabatic lapse rates
- Clausius-clapeyron equation

### **Aerological diagrams**

- Theory and applications mixing of air masses;
- Stability of dry and moist air;
- Convection, precipitable water and quantitative precipitation forecasting.

### **Books Recommended:**

- i) *Atmospheric Thermodynamics* by J.V. Iribarne and W.L. Godson, (second edition)., Kluwer Academic Publisher.

## **BIPM 503 Numerical Weather Prediction**

### **Historical background**

- Overview of a numerical weather prediction operation
- Uses of numerical products

### **Map projections**

- Meteorological equations in map coordinates

### **Numerical methods:**

- Finite differencing
- The Taylor series approach and the polynomial fitting approach
- Truncation errors
- Interpolation and data filtering
- Computations stability of explicit and implicit techniques
- Numerical solution of the advection and diffusion equation
- Semi-implicit methods
- Solution of elliptic boundary value problems
- Relaxation method

**Atmospheric models**

- Simplified General Circulation Model
- High resolution Regional Model (HRM)
- Regional Climate Model (RegCM4)
- Filtered barotropic model
- Non-filtered models
- Shallow water equations
- Two layer primitive equations baroclinic model
- Multi level models
- Boundary conditions

**Inclusion of physical effects in numerical models**

- Diffusion
- Surface drag
- Large-scale condensation heating
- Cumulus convection
- Radiation
- Quantitative precipitation forecasting

**Initialization and objective analysis**

- Meso-scale models
- Practical exercise in finite differencing, interpolation, filtering, relaxation technique
- Filtered barotropic model
- Shallow-water equations

**Books Recommended:**

- i) *Numerical Prediction & Dynamic Meteorology* by Haltiner, G.J., and Williams, R.T (2<sup>nd</sup> edition), McGraw Hill Book Company Inc., New York
- ii) *Workbook on Numerical Weather for the Tropics for the training of Class I & II Meteorological Personnel* by T.N. Krishnamurti WMO No. 669., Geneva, Switzerland.

**BIPM 504 Physical Meteorology****Basic Radiation laws**

- Scattering
- Transmission
- Absorption of radiation
- Surface albedo
- Origin and nature of terrestrial radiation
- Absorption and emission by water vapour, carbon dioxide and ozone, radiation charts
- Heat balance of the earth atmosphere system
- Principles of remote sensing by earth satellites.

**Cloud microphysics**

- Nucleation
- Condensation nuclei
- Growth of cloud droplets and crystals by diffusion

- Bergeron-findeisen process
- Coalescence of cloud droplets
- Warm clouds
- Hail
- Aircraft icing
- Artificial modification of cloud and precipitation.

### **Atmospheric Electricity**

- Electric field in the atmosphere
- Electrical properties of the thunderstorm
- Lightning discharge

### **Introduction to Radar Meteorology**

#### ***Books Recommended:***

- i) *Compendium of Meteorology* by WMO., Volume I, Part 2, Physical Meteorology, WMO No. 364., Geneva, Switzerland.
- ii) *A short course in Cloud Physics* by Rogers, R.R. and M.K. Yau, Pergamon Press, Oxford, London.

### **BIPM 505 Synoptic Meteorology**

#### **Kinematics of horizontal motion**

- Relationship between streamline and trajectories
- Divergence
- Relative vorticity
- Deformation fields
- kinematics vertical velocity.

#### **Fronts and Frontogenesis**

- Frontal discontinuities
- Kinematics of frontogenesis
- Characteristics of frontal structures
- Motions of fronts.

#### **Diagnosis of synoptic systems**

- Thickness equation
- Quasi-geostrophic thermal advection
- Geopotential tendency equation
- Vertical motion diagnosis
- Pressure tendency equation
- Cyclogenesis.

#### **Prediction in the synoptic scale**

- Persistence, climatological, statistical, and dynamical
- Prediction of cloud and precipitation
- Advection of moisture fields
- Applications of satellite and radar information
- Cumulus convection and stability analysis.

**Tropical analysis and prediction**

- Monsoon circulations
- Inter tropical convergence zone
- Easterly waves
- Tropical cyclones.

**Books Recommended:**

- i) *Introduction to Meteorology* by Petterssen, S., McGraw Hill Book Company, New York, USA.
- ii) *Compendium of Meteorology for use by Class-I & Class-II Meteorological Personnel volume I part 3, Synoptic Meteorology* by F. Dejeant W.H.T. Morth, WMO No.364., Geneva, Switzerland.
- iii) *The Meteorology of Pakistan* by K.M. Shamshad., Pakistan Met. Department.

**BIPM 506 Synoptic Meteorology Practicum**

- Analysis of isobars, height fields, streamline-isotachs, isotherms & moisture field construction and analysis of thickness fields
- Computation of divergence, vorticity and kinematic vertical velocity-frontal analysis surface and vertical cross-sections
- Diagnostic analysis
- Geopotential tendency and vertical velocity
- Vorticity advection
- Thermal advection
- Analysis of aerological diagrams
- Stability indices
- Icing potentials
- Preparation of prognostic charts and route forecast folders for aviation, forecasting competition among trainees.

**BIPM 507 Climatology****Climatic classification**

- Regional Climatology
- Meso and micro-climatology.

**Climatic change**

- Meteorological factors affecting climate
- Green house gases
- Paleo climatology
- The predicted climate scenarios in the year 2000.

**Climatological methods**

- Climatological statistics
- Probability theory
- Measures of climatological parameters
- Binomial

- Poisson
- Normal distribution
- Log-normal distribution
- Correlation and regression
- Time series analysis
- Computations and use of standard computerized statistical packages in climatological data processing.

**Books Recommended:**

- Fundamentals of Physical Geography* by David Briggs and Peter Smithson.,81 Adam Drive, Totowa, New Jersey, USA.
- Physics of the Climate* by Peixoto, J. P., MIT Press, Massachusetts, USA.
- Methods in Climatology* by V. Conrad and L.W. Pollak., Harvard University Press.
- Mathematical Statistics* by Jhon E. Freund., New York, USA.
- Statistics* by Frank Ayras, G.R., *Statistics*, Schaum's Outline Series, New York, USA.
- Basic statistical computing* by A.H. Craven & G.M. Clarke
- The Meteorology of Pakistan* by K.M. Shamshad., Pakistan Met. Department.

**BIPM 508 Physical Oceanography**

- The world's oceans
- History and morphology
- Properties of sea water
- General circulation of the oceans
- Energy exchange between the oceans and atmosphere
- Dynamics of ocean circulation
- Wind waves and wave forecasting
- Tides and swells
- Storm surge and its predictions
- Practical exercises.

**Books Recommended:**

- Compendium of Meteorology.* Volume-II, Part 3 Marine Meteorology, WMO No. 364, Geneva, Switzerland.
- Oceanography, Exploring the Planet Ocean* by J.J. Bhalt, D. Van Nostrand Company.
- Contributions in Oceanography and Meteorology* by College of Geo-science, Number 279-318, Texas, A.S.M. University, Texas.

**BIPM 509 Air Pollution Meteorology**

- Turbulence in the atmospheric boundary layer
- Diffusion theory and experiments
- The Gaussian Plume rise due to momentum and buoyancy
- Estimation of diffusion parameters from meteorological data
- Dispersion of pollutants by meso scale and synoptic scale motions
- Case studies and practical exercise.

**Books Recommended:**

- i) *Compendium of Meteorology*. Volume-II, Part 6, Air Chemistry and Air Pollution Meteorology., WMO, Geneva, Switzerland.

**BIPM 510 General Hydrology**

- The hydrological cycle
- Physical characteristics of the watershed
- Precipitation amount, intensity, duration and distribution
  
- Estimation of missing precipitation data
- Evaporation and evapotranspiration
- Infiltration and soil moisture
- Surface run-off
- Hydrographic and unit hydrographic
- Groundwater
- Water balance
- Hygrometry
- Elements of flood forecasting.

**Books Recommended:**

- i) *Hydrology in Practice* by Shaw E.M., (2<sup>nd</sup> edition), Chapman & Hall., London, U.K.
- ii) *Principles of Hydrology* by Ward R.C. (2<sup>nd</sup> edition), McGraw-Hill, New York, USA.
- iii) *Guide to Hydrometeorological Practice* by WMO Applied Hydrology by K.N. Mutreja., Tata McGraw Hill, New Dehli, India.

**BIPM 511 Research**

The primary aim of this module is to familiarize the trainees about the fundamentals of research. Each trainee shall be required to develop a research problem of his choice from an approved list of topics that shall be prepared by the teaching staff. Satisfactory completion and submission of a research report or monograph in accordance with a format that shall be determined later shall form a part of the requirements for the successful completion of the course.



## **Basic Instruction Package for Seismology Technician (BIP-ST)**

### **Preliminary Seismology Course (Duration 18 week)**

S.No.	Course No.	Particulars/Subject	Credit
1.	BIPST 601	Introduction to Seismology	3 + 2
2.	BIPST 602	Geology of Earthquakes	4 + 0
3.	BIPST 603	Seismometry	4 + 0
4.	BIPST 604	Basic Mathematics – I	3 + 0
5.	BIPST 605	Computer Skills – I	2 + 2

### **BIPST 601 Introduction to Seismology**

- Internal structure of the earth
  - i) Crust
  - ii) Mantle
  - iii) Core
- Causes of Earthquakes
- Classification of Earthquakes
- Earthquake Reporting
- Earthquake Catalogue
- Historical Earthquake in Pakistan
- Seismic Waves
  - i) Body Waves group
  - ii) Surface Waves group
- Determination of Magnitude
- Intensity and Intensity Scales
- Epicentral Location
- Snell's Law

### **BIPST 602 Geology of Earthquakes**

- Continental Drift
  - i) Evidences of Continental Drift
  - ii) Continental Drift Theory
- Sea floor Spreading
- Origin of the oceans
  - i) Hess's Driving Force
- Types of Plate Boundaries
  - i) Convergent Plate Boundaries
  - ii) Divergent Plate Boundaries
  - iii) Transform Plate Boundaries
- Types of Faults
  - i) Thrust faults
  - ii) Normal Faults
  - iii) Strike Slip Faults

### **BIPST 603 Seismometry**

- Simple Harmonic Motion
- Damped Harmonic Motion
- Forced Harmonic Motion
- Analogue Instruments
  - i) First Generation instruments
  - ii) 2nd Generation Instruments
- Digital Instrumentation

**BIPST 604 Basic Mathematics – I**

- Matrices and Determinants
  - i) Basic Concepts
  - ii) Determinants
  - iii) Higher Order determinants
  - iv) Gauss Jordan Method
- Basic Concept of Derivatives
  - i) Introduction of higher order derivatives
- Different methods of integration

**BIPST 605 Computer Skills – I**

- Operating systems
  - i) Window Operating System
  - ii) Linux Operating System
- Introduction to seismic data analysis software
  - i) SCREAM
  - ii) SEISAN
- Basics of FORTRAN Computer Programming

**Basic Instruction package for Seismology  
(BIP–S)**

**Advance Seismology Course (Duration 32 week)**

S.No.	Course No.	Particulars/Subjects	Credit
1.	BIPS 701	Introduction to Seismology	3 + 0
2.	BIPS 702	Plate Tectonics	3 + 0
3.	BIPS 703	Seismological Instrumentation	2 + 1
4.	BIPS 704	Basic Mathematics – II	3 + 0
5.	BIPS 705	Tsunami	3 + 0
6.	BIPS 706	Computer Skills – II	1 + 3
7.	BIPS 707	Seismotectonics and Seismic Hazard Technique	2 + 1

## **BIPS 701 Introduction Seismology**

### **Internal structure of the earth**

- Crust
- Mantle
- Core
- Theory of Isostasy
  - i) Pratt's Model
  - ii) Airy's Model

### **Basic Seismology**

- Causes of Earthquakes
- Seismic Waves
  - i) Body Waves group
  - ii) Surface Waves group
  - iii) Refraction
  - iv) Depth Phases
- Magnitude
  - i) Determination of Magnitude
  - ii) Types of Magnitude
- Intensity and Intensity Scales
- Epicentral Location

### **Reflection Seismology**

- Snell's Law & its applications
- Fermat's Principle
- Huygens - Fresnel Principle
- Reflection in Layered Media
- Ray Theory, Travel Time
- Seismic Waves Velocity of Rocks

### **Basic Concepts of Focal Mechanism**

## **BIPS 702 Plate Tectonics**

### **Continental Drift and Sea Floor Spreading**

- Introduction to Geological Time Scale
- Continental Drift Theory
  - i) Evidence of continental Drift
  - ii) Continental Reconstructions
- Sea floor Spreading
- Origin of the oceans
  - i) Hess's Driving Force
  - ii) Mid Oceanic Ridges
- Geomagnetic Reversals
- Introduction to Transform Faults

**Plate Boundaries**

- Types of Plate Boundaries
  - i) Convergent Plate Boundaries
  - ii) Divergent Plate Boundaries
  - iii) Transform Plate Boundaries
- Subduction Zones
- Ocean Trenches

**Introductions to Structural Geology**

- Stress and Strain Mechanism
- Folds
  - i) Types of Folds
- Faults
  - i) Criteria for Reorganization of Faults
  - ii) Mechanism of structural features
- Types of Faults
  - i) Thrust faults
  - ii) Normal Faults
  - iii) Strike Slip Faults
- Structural Features of Pakistan

**BIPS 703 Seismological Instrumentation**

- Simple Harmonic Motion
- Damped Harmonic Motion
- Forced Harmonic Motion
- First Generation instruments
- 2nd Generation Instruments
- 3rd Generation Instruments
- Seismic Noise Measurement
  - i) Signal to Noise Ratio
- Transfer Function
- Aliasing and Anti-Aliasing
- Networking & Communication

**BIPS 704 Basic Mathematics – II**

- Limits and Functions
- Matrices and Determinants
  - i) Basic Concepts
  - ii) Determinants
  - iii) Gauss Jordan Method
- Derivatives and Integrals
- Applications of Derivatives and integral
- Laplace Transforms
- Fourier Transforms
- Waves Equation

**BIPS 705 Tsunami**

- Tsunami
- Mechanism of Tsunami generation
- Causes of Tsunami
- Propagation of Tsunami in Deep and Shallow Ocean
- Sources of Tsunami
- Run-up height and inundation
- Effect of Ocean Bottom & Coastal Topography
- Detection and Observation of Tsunami

**BIPS 706 Computer Skills – II****1. *SEISAN 8.1***

SEISAN Installation  
 GCF data conversion into SEISAN Format  
 Seismic data interpretation through SEISAN  
 Earthquake location through SEISAN  
 Database in SEISAN  
 Computer Exercises

**2. *SCREAM 4.4***

Installation  
 Configuration  
 Data Acquisition/ Station IP Pinging  
 Event Identification, Interactive Phase Picking

**3. *Linux (Ubuntu)***

Introduction to Linux environment in Seismology  
 Basic UNIX commands, work station, Access to Server

**FORTRAN**

a) FORTRAN language basics

**Unix/Linux**

UNIX/Linux command basics

- i) Handling files
- ii) Remote login
- iii) Data transfer
- iv) Shell script

**GMT**

- i) GMT command basics
- ii) Commands and options
- iii) Simple shell script with GMT
- iv) Exercises

**4. *SeiscomP3***

Software Operation  
 Seed Link Server  
 SeiscomP3 data archiving modules (scrttv,scmv,scolv,scsv)  
 Event Analysis through SeiscomP3  
 Database in SeiscomP3

5. ***GUITAR***  
Software Operation  
Tsunami Simulation (Tsunami Generation)
6. ***SEISMIC DATA FORMATS***  
Seed, Mini Seed, GCF, Seisan-Sud

## **BIPS 707 Seismotectonic and Seismic Hazard Techniques**

### **Seismotectonic**

- Introduction
- Seismotectonic analysis
  - i) Qualitative analysis
  - ii) Quantitative analysis
- Induced seismicity

### **Seismic Hazard Techniques**

- Deterministic Seismic Hazard Analysis
- Probabilistic Seismic Hazard Analysis

### ***Books Recommended:***

- i) ***Global Tectonic*** by Philip Kearey & Frederick J. Vine. (3<sup>rd</sup> edition), Wiley Blackwell, A John Wiley Sons Ltd.
- ii) ***An introduction to Geophysical Exploration*** by Philip Kearey, Michael Brooks & Ian Hill.
- iii) ***The Mechanics of Earthquakes and Faulting*** by Christopher H. Scholz., Cambridge University Press, U.K.
- iv) ***Physical Geology*** by Plummer, Mcgeary & Carlson., McGraw Hill.
- v) ***The Geology of Earthquakes*** by Robert S. Yeasts, Kerry Sieh & Clarence R. Allen., Oxford University Press.
- vi) ***Anatomy of Seismograms*** by O.Kulhanek, Elesvier, University of California.
- vii) ***Introduction to Seismology*** by Peter M. Shearer., Cambridge University Press, U.K.
- viii) ***Advanced Engineering Mathematics*** by Erwin Kreyszig., Wiley Publisher.





GOVERNMENT OF PAKISTAN  
PAKISTAN METEOROLOGICAL DEPARTMENT

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