CURRICULUM FOR BASIC INSRTUCTIONAL PACKAGE FOR METEOROLOGICAL TECHNICIAN (BIP-MT FIRST YEAR)

Table1. FIRST SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS
1	BIP 111	Codes & OBS	4	Core
2	BIP 112	General Meteorology	3	Core
3	BIP 113	Physics (Heat)	3	Required
4	BIP 114	Introduction to Computer	2	Required
5	BIP 115	General Studies	2	Core
6	BIP 116	Aeronautical Meteorology I	3	Core
7	BIP 117	Algebra	3	Core
8	BIP 118	Agricultural Meteorology I	4	Core

Table 2 SECOND SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS
1	BIP 121	Upper Air Observation	3	Core
2	BIP 122	Meteorological Instruments &Maintenance	4	Core
3	BIP 123	General Statistics	2	Core
4	BIP 124	Environmental Pollution	3	Core
5	BIP 125	Marine Meteorology I	2	Core
6	BIP 126	Calculus	3	Required
7	BIP 127	Physics (Mechanics)	4	Required
8	BIP 128	Climatology	3	Core

Table 3 THIRD SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS
1	BIP 131	Physics (Electricity)	2	Required
2	BIP 132	Hydro Meteorology	3	Core
3	BIP 133	Remote Sensing & GIS	3	Core
4	BIP 134	Plotting	3	Core
5	BIP 135	Environmental Disaster & Risk Management	4	Core
6	BIP 136	Meteorological Instrument Fabrication & Calibration		Core
7	BIP 137	OJT		Core

COURSE CONTENTS AND LEARNING OUTCOMES FOR BASIC INSRTUCTIONAL PACKAGE FOR METEOROLOGICAL TECHNICIAN (BIP-MT)

LEARNING OUTCOME ON CODES & OBSERVATION I

- To be able to identify and understand the principle behind the formation and associated weather events
- Ability to collate climatic data for research purposes
- To be able to identify hydrometeors and their method of observation
- To be able to code and transmit information
- Ability to collate climatic data for research purposes
- To be able to conduct necessary observations and understand the techniques
- To be able to identify clouds and their associated characteristics and formation

. CODES AND OBSERVATIONS I: (BIP 111)

1. Brief introduction to instrument used in taking meteorological observations.
2. Measurement of meteorological variables and procedure of observation, Specific features of Meteorological measurements; Direct and Indirect. Measurement of Temperatures; Air, Maximum, Minimum etc. Measurement of Humidity; Relative Humidity autographic instruments, derived values with the aid of Humidity slide rule, Measurement of Atmospheric Pressures (Barometers,) Barographs).
3. Measurement of Clouds; Types, Amount and Height (Ceilometers, ceiling Ascent, Cloud, Atlas and Pictures)
4. Measurement of surface Winds. Direction and speed; (Anemometers, and Beaufort scale for estimation).
5. Precipitation Measurements (Rates and Records of precipitation) Solid or Liquid, Gauges units. Precipitation (Amount and Duration). Automated weather station for intensity.
6. Measurement of Evaporation – Piche Evaporimeters
7. Visibility; General unit measurements, Definition of visibility (hydrometeor and lithometoes) and Visibility at night. Prevailing visibility/ directional visibility
8. Measurement of solar radiation (Sunshine recorders, Gunn Bellani radiation integrator and solarimeter).
9. Methods and procedures of observations Standard time, accuracy and measurement (UTC unit) Standard International Block and stations numbers e.g. Nigerian Stations.
10. Codes: Applications of SYNOP code for observation Section O -5
11. Present weather, Visibility and (Direction and speed), Application of METAR and SPECI Codes.
12. introduction to "9" special phenomenon groups i.e. 9spspspsp of synoptic message
13. Introduction to supplementary information groups of synoptic message e.g 5j1j2j3j4, 4ffff, 55408, 4esss etc.
14. section 5 555 of synoptic message e.g. 1sntxtxtx 2sntntntn 30uuu 40rrr
15. METAR modifications and corrections
16. SPECI modifications and corrections

LEARNING OUTCOMES ON GENERAL METEOROLOGY

- to appreciate the physical structure of the atmosphere
- to enable the student to understand the physical processes of energy transfer from the sun to the earth surface and its application
- the principles of atmospheric pressure and its roles in the study of the atmosphere and aviation in specific/weather occurrence
- the principles of atmospheric temperature and its roles in the study of the atmosphere/climate variability
- to understand the importance of humidity in the study of the atmosphere
- to understand movement of air constituents
- to understand the concept of air flow and its effect to weather development
- to be able to understand the formation and effect of hazardous weather

GENERAL METEOROLOGY: (BIP 112)

1. The composition and structure of the atmosphere: Saturated or unsaturated atmosphere ; atmospheric ozone; water Vapour; carbon dioxide; thermosphere; interplanetary gas; Vertical divisions of the atmosphere; Troposphere; Stratosphere; Mesosphere; Thermosphere; Ionosphere.
2. Heat exchange processes in the atmosphere; solar and terrestrial radiation; Conduction and convection; advection; mechanical, thermal, turbulence and clear air turbulence; energy budget of the atmosphere; effect of radiation at the earth's surface; temperature difference between land and sea surfaces(land and sea breeze).
3. Air temperature; basic principles of temperature measurements; Celsius, Fahrenheit and Kelvin temperature scales, Thermometers, physical processes used in thermometry, types; thermograph, measurement of air temperature; exposure; horizontal and vertical variations of air Temperature.
4. The effect of gravity on the atmosphere, air density, Atmospheric pressure, units; measurement; the hydrostatic equation; Horizontal and vertical variation of pressure; pressure to sea level; the ICAO Standard atmosphere; the barometer used as an altimeter; Diurnal variation of pressure; Pressure gradient and its significance.

5. Moist air; the three states of water, solid, liquid and gaseous; density; Water vapour pressure; saturation vapour pressure; evaporation Condensation; freezing; sublimation; latent Heat
6. Moisture indicators; relative humidity; mixing ratio and dew point; water Vapour pressure
7. Elementary theory of the wet-bulb thermometer; principles of the Psychrometer and The hygrometer; rudiments of cloud, fog and precipitation. Formation and visibility. The effect of aerosols (fog and dust on visibility).
8. Expansion or compression of a rising or falling air parcel; variation of the parcel temperature with height; isobaric expansion and adiabatic expansion; the influence of condensation; basic knowledge of the vertical stability; non-saturated air and saturated air.
9. Forces that affect atmospheric motion e.g pressure gradient force, gravity force, Coriolis Effect and friction.
10. Elementary knowledge of synoptic and dynamic meteorology; air motion; Significance of scale; the winds and their causes; rudiments of the general circulation in the tropics and in non-tropical regions; local winds; diurnal wind variation (breezes) and annual wind variations (monsoons); relation between the horizontal pressure gradient and the Winds; Buys-Ballot's law and the geostrophic wind; cyclones and Anticyclones; air masses and fronts; ITD and thunderstorms.

LEARNING OUTCOME FOR PHYSICS (HEAT)

Understanding of the physical laws and its application to atmospheric science

PHYSICS (HEAT): (BIP 113)

1. Concept of heat, heat sources, temperature and temperature scales
2. Thermometers: liquid-in-class, gas and electrical thermometers
3. Effect of heat on matter: solids, liquids and gases. Solids: thermal expansion – linear, area and volume. Liquids: apparent, real and absolute; expansion of water, Gases: adiabatic
4. Application: Bimetallic strips, Heat capacity, specific heat capacity and calorimetry, land and sea breezes, phase change, latent heat
5. Heat transfer: conduction, convection and radiation. Solar and terrestrial radiation.
6. Gas laws: Boyles, Charles, pressure and Dalton's law
7. Kinetic theory of gases. Boiling, evaporation, condensation, vapour pressure.

LEARNING OUTCOME FOR COMPUTER STUDIES

To improve the trainee's technical and operational skills in data management practice and its application at work

INTRODUCTION TO COMPUTER STUDIES: (BIP 114)

1. Evaluation of the computer system: Definitions of computer; History of the computer(The beginning of computer age); Generation of computer; Types of computers; Classification of digital computers; Characteristics of computers; Application of computer in the society.
2. Functional parts of the digital computer. Hardware (Input units, output units, Processing units, storage units Communication units) and software (types of computer software, operating system, application software)
3. Computer safety and maintenance (Top computer mistakes beginners makes, Basic Troubleshooting Techniques, Maintaining your Computer).
4. Using the computer (Buttons and parts of on a computer, setting up a computer, computer safety and maintenance)
5. Application of computer in weather studies.
6. Introduction to software packages.
7. Programming. Creating and Publishing online material
8. Data Processing.

LEARNING OUTCOME FOR GENERAL STUDIES

- To provide background knowledge of meteorology
- Application of civil service rules at work

GENERAL STUDIES: (BIP 115)

1. Ethics of the Job/ documentation processes.
2. Accessing and obtaining information – Meteorological information via libraries, database and internet searching.
3. Historical context – The scientific and technological advances that have contributed to the development of meteorology and its application.
4. Written communications – Written communications within specified time limits in a concise, accurate and comprehensible way, including use of word processing and presentation programmes.
5. Oral presentations – Presentations within specified time limits, in which the context and style of delivery accurately conveys information in ways that can be understood by the audience.
6. Concept and significance of library and information centre
7. Types of library
8. Information sources and resources
9. Information services
10. Information user
11. Information need
12. Information organization

LEARNING OUTCOMES FOR AERONAUTICAL METEOROLOGY I

- Familiarize students to terminologies in aeronautical meteorology.

- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to understand the various aviation meteorological hazards and to know what to do to ameliorate the effect of such hazards on operation of aircrafts.
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

AERONAUTICAL METEOROLOGY I (BIP 116)

1. Definitions of Terms: Aeronautical Meteorology, Meteorological report, observation, visibility, runway visual range. Altitude, elevation height, aerodrome elevation, flight level, transition level, and aerodrome meteorological minima
2. Observing techniques. Surface wind direction and speed, including changes and variations. Visibility and runway visual range, including spatial and temporal variations in RVR observations, cloud amount, height and type and spatial and temporal variations. Vertical visibility, observations using automatic instruments such as ceilometers. Pressure measurements for the purpose of determining QFE and QNH.
3. Reporting, coding and dissemination of weather information. Complete knowledge of international meteorological codes related to observations such as METAR and SPECI. Knowledge of procedure for dissemination of weather information at the aerodrome, including the special needs of ATC units. Knowledge of the procedures for the preparation of the plain language forms of meteorological messages.
4. Hazardous phenomena: Aircraft icing. Elementary knowledge of icing types; formation, accretion rates and association of icing with clouds; turbulence, elementary knowledge of turbulence near the ground as related to topography; elementary knowledge of high level turbulence (CAT) and its association with jet streams. Wind shear and volcanic ash.
5. Introduction to the responsibilities of ICAO and WMO in aeronautical meteorology.

6. Aeronautical telecommunications. Elementary understanding of the general organization of aeronautical telecommunications, but they should have a good working knowledge of the operation of the aeronautical fixed service.
7. WMO documents: Technical regulations, (WMO-No 49) Vol II – Meteorological service for International Air Navigation. Manual on codes (WMO-No 306). Guide to Meteorological Instruments and methods of observation (WMO-No 8). Weather reporting (WMO-No 9).

LEARNING OUTCOME FOR ALGEBRA

To develop the calculative skill in relation to the scientific nature of the atmosphere

ALGEBRA: (BIP 117)

1. Simultaneous equations: Linear and quadratic.
2. Indices.
3. Logarithms: Natural and any base.
4. Quadratics equations: Algebraic and graphical solutions, roots of quadratics.
5. Variations: Linear, Inverse, joint and partial.
6. Inequalities: Linear and quadratic.
7. Polynomials: Factor theorem; Remainder's Theorem; Pascal's Triangle.
8. Series and Progression.
9. Partial fraction.

LEARNING OUTCOME FOR AGROMETEOROLOGY

- To understand the effect of meteorological and climatic data to crops and livestock
- To employ meteorological information to improve agricultural products

AGROMETEOROLOGY I: (BIP 118)

1. Definition, scope and aims of Agrometeorology and other allied disciplines.
2. The relationship between weather, climate and agriculture as it affects soil, plants, farm animals, pests and diseases. Pest of crops and animals, farm building and equipment.
3. Artificial modifications of the Meteorological and Hydrological regimes namely; glass green houses, windbreaks, and shelter belts, irrigation, mulching.

4. The history of Agriculture and its relationship with association science. Agricultural Ecology and Ecosystem Distribution and Classification of Vegetation belts in Nigeria. Weather and climatic modification.
5. General production practice of field crops, crop production e.g. Maize Production factors for optimum yield of field crops. Factors affecting crop yield; Environmental factors – rainfall, CO_2, temperature, radiation, wind, light, evaporation water supply, nutrient, weed, pest and disease soil physical condition. Plant population, field of individual plant and community.
6. Plant protection definition of pest, important of pest. Importance of plant protection. Types of Pests: Polyphagous pest, Locusts, Termites, Bihar hairy Caterpillar, Cutworm, Greasy Cutworm, Damage caused by locust phase. Theory of locust, life cycle of locusts and control. Observations on crop pests and diseases.
7. Factors affecting disease development and propagation(the role of the macro-climatic environment) namely, temp, humidity, soil pH, wind, soil texture.
8. Control of plant diseases
   Cultural methods
   . Proper selection of geographical area
   . Selection of field
   . Choice of time of sowing
   Exclusion method
   Eradication
   . Rogueing
   . Crop sanitation
   . Eradication of alternate and collateral hosts
   . Heat and Chemical treatments of diseased plants
   . Biological control
9. Pests of Crop plants
   Insect pests (the classification based on habits and parts of plants attached) barriers, sucking insects, leaf eating insects, fruit and seed eaters etc.
   Other Pests such as Birds, Rodents and Monkeys
10. Diseases of Crop Plants
    Fungal diseases
    Bacterial diseases
    Viral diseases
    Poultry diseases
    Symptoms and control

11. Phenology Definition of phenology Method of phonological observations. Different phases of phenological observations in different crop plants. Biological Observations (Phenological observations)
    Phonological phases in cereals
    Germination
    Emergence sprouting
    Tillering
    flowering
    earning

milky ripeness
waxy ripeness
Tisselling

Importance of phenological observations

12. Agrometeorological elements and their methods of observations.
13. Definition, climatic elements, Biological elements, conditions of observation, Agrometeorological station and Networks, Observation of physical elements, Observation of biological Character/Elements, Detail observation of high accuracy.
14. Prevention and mitigation of Agrometeorological calamities in Nigeria.
15. Evapotransition Studies .
16. Agrometeorological water balance

P + I =ET + R + D + S

Evaporation
Evapotranspiration (Actual and Potential)
Factors affecting evapotranspiration
Factors affecting evapotranspiration
Calculation and Measurements of evapotranspiration
Water balance: Lysimetry
Aerodynamic profile approach (Bowen into
Combination methods (Penman equation)
The use of evapotranspiration data.

17. Soil Water

Soil water availability
3 categories of soil water
Capillary
Hygroscopic
Gravitational
Field capacity
Wilting point
Soil water in relation to plant growth.
Plant response to water deficit and excess moisture
The need for soil Moisture

18. Agrometeorological stations

Classification
Principal
Ordinary
Auxiliary
Agromet station for specific purposes

19. Climatic normal for livestock's: poultry birds, Goat, Sheep, Pigs and Cattle. Meteorological equipment of crop plants for rice, sugar cane, cotton, maize, potatoes etc. Animal's production systems, uses of animals. Outdoor animals and Meteorological elements.
20. Water and the Hydrological Cycle in Agriculture moisture characteristics of soil water and vegetation. Determination of water loss from land surface fundamental of the evaporation process. Existing methods of determining evaporation Energy balance of estimating evaporation. Aerodynamic estimation of evaporation combination model methods of penman and others. Development of original

penman equation. Evaporation formulae of priestle – Taylor and Penman – Monteith special forms of precipitation Dew, Snow, soil moisture Budgets – Irrigation needs

LEARNING OUTCOME FOR UPPER AIR OBSERVATION

The students should be able to carry out sounding and the use of the instruments.

UPPER AIR OBSERVATION: (BIP 121)

1. General – Units of measurements. Meteorological balloons: There are three types of balloon colours in use for the measurement of upper wind:- Red, blue and white colour. The state of the sky determines the colour of balloon to be used. Gases for inflation of Meteorological balloon helium, or hydrogen gas. Hydrogen generator for Meteorological purposes. Theory of upper-wind measurement. Care and handling of Meteorological balloons. Sizes of Meteorological balloons. The Pilot – Balloon Theodolite. Ceiling measurement using pilot balloon (determination of cloud base). Optical Theodolite using pilot balloon
2. Pilot Balloon Codes PART A, B, C, D,
3. Temperature Message Identifier TTAA Radiosonde Transmitter

The weather elements observed are: Pressure, Temperature, Wind direction and speed, humidity and dew point.

4. Radio sounding of the upper atmosphere. General – units of measurement. The Principle of the radio sounding system: Principle of the radio sounding and ascent evaluation.

LEARNING OUTCOMES OF METEOROLOGICAL INSTRUMENTS

- The students should be able to know the factors of siting the instruments and spacing of instruments
- They should be able to understand the underlying principle of the instruments in relation to units and dimensions and their mode of operation
- They should be able to conduct necessary observations and understand the techniques

METEOROLOGICAL INSTRUMENTS & MAINTENANCE: (BIP 122)

1. Direct and Indirect Meteorological measurement
   Measurement of meteorological variables
   Specific features of Meteorological Measurement
   Direct Reading Instruments: Thermometers, Barometer, Wind Vane, Cup-Counter Anemometer, Class A Pan, Gunn Bellani Radiation Integrator, Raingauge, Sunshine Recorder and Ordinary Anemometer.

Autographic Instrument (Indirect Reading Instruments): Thermograph, Barograph, Hyetograph and Hygrograph. Desirable Characteristics of Meteorological Instruments (Accuracy, durability and reliability).
General requirements for sitting and exposure of Meteorological Instruments.

2. Measurement of atmospheric pressure
Nature of atmospheric pressure – Units of measurements; Principles underlying the operation of atmospheric pressure measuring
Instruments; Mercury barometers; Kew Pattern Barometer and Fortins Barometer; Aneroid barometers; analogue and digital; The Principle of the barograph; Exposure of atmospheric pressure measuring instruments.

3 Measurement of air temperature; Nature and units of measurement of air temperature, temperature scales used in Meteorology and conversion. Principles underlying the operation of air – temperature measuring; Instruments; Mercury-in-glass thermometers, spirit-In-glass thermometers; The bimetallic thermometers, station thermograph ; Exposure of air temperature measuring instruments (source of errors); Re-Setting of thermometers.

4 Measurement of atmospheric humidity; Nature and units of measurement of absolute humidity, relative humidity and dew point and other humidity parameters; General principles of hygrometers.
Humidity measuring instruments based on change of dimension of Hygroscopic substances - the hair hygrometer, the psychrometer.
Automated psychrometer and recording Psychrometer.

5 Measurement of surface wind direction and speed; Wind direction and wind speed – specific feature units of measurement; Principles of wind measuring instruments; The pressure plate anemometer; Cup counter Anemometer- The rotation sensor cup – wheel – propeller; and Anemometers measuring run of wind.

6 Measurement of precipitation; General liquid and solid precipitation – units of measurement; Principles of the Point measurement of precipitation. Non – recording precipitation gauges – daily rain gauges of the unshielded and shaded types. Recording precipitation gauges – siphon (float type – tipping bucket and Weighing – balance type
Exposure requirements concerning precipitation point – measurement instruments. Routine care of precipitation measuring instruments; Factors affecting the accuracy of point – precipitation measurements (Evaporation Loss). Measurement of evaporation

7. General units of measurements, Principles of evaporation measuring
Instruments, the evaporation pan: Class A Pan – (the hook gauge type). General requirements for the evaporation – measuring instruments' exposure, routine care of evaporation – measuring instrument.

8 Sunshine duration measurement
General principles of sunshine duration measurement
The Campbell Stokes sunshine duration recorders. Sitting and exposure requirements for sunshine duration measuring
Instruments, factors affecting the sunshine records (Cloud cover, Precipitation). Routine care of the Campbell Stokes sunshine recorder.

9 Automation of the measurement of Meteorological variables. Technical and economic aspects of automation objectives. Classification of automatic weather stations. Basic block diagram of an automatic weather station. Sensors used with automatic weather stations. Maintenance of automatic weather stations. Reliability of automatic equipment. Standard, quality control, calibration and inter comparison.

LEARNING OUTCOMES ON STATISTICS

- To analyse and interpret climatic data
- To understand the place of statistics in the use of weather and climate data

STATISTICS: (BIP 123)

1. Introduction: Definitions, meaning of statistics, examples with natural situations. Data collection and storage.
2. Data arrangement: Mean, median, mode; Mean of grouped and ungrouped data. Assumed Mean. Arithmetic and Geometric mean. Median and mode for grouped data Average mark.
3. Graphical representation of data: Pie chart, bar chart, Frequency table, cumulative frequency, Ogive.
4. Regression and Correlation

   Scatter graphs, relationships between two variables and scatter graphs (construction, line of best fit, estimate from scatter graphs significance of the scatter graph, limitations of scatter graph). Regression lines (definition, equations of approximating curves i.e. exponential and polynomial curves); computing regression lines (equation of the line or straight line; method of least squares, measuring the deviations; the regression of y on x; the regression of x on y; graphing regression lines; the use of regression lines; choice of regression line and Regression coefficient). Correlation (computation of r; interpretation of r; types of correlation; Spurious correlation; Rank correlation r^2. Applications to time series graphing the data; the equation of a least square line and fitting the data; estimates. Multiple linear regression and non–linear regression.
5. Probability

   Introduction: Definitions of probability, events and various classes of events; trials and random variables and probability symbols. Conditional probability; independent and dependent event; mutually exclusive events; mathematical expectation; permutations and combination. Probability distributions, the binomial distribution (a short-cut i.e. P(X) =nCx Pxq (n-n), when can it be used, mean and standard deviation of Binomial distribution, some properties, the Poisson distribution (Poisson distribution, when it can be used, mean and standard deviation of the Poisson distribution and some properties and the Normal distribution some properties of the Normal distribution, the relationship between binomial and normal distribution.

6. Estimation

Tests of significance; testing a hypothesis (the null hypothesis, testing the Null hypothesis, rejection of the null hypothesis, non-rejection of the Null hypothesis, confidence level and the risk of rejecting a true hypothesis, Confidence level and the risk of not rejecting an incorrect hypothesis; type I and II errors; one-fact and two-tail tests. Testing the difference between means and properties (Distribution of the difference between properties).

7. Small Sampling Theory
   Small Samples; "Student's" t-distribution, confidence intervals; Test of hypothesis and significance; the chi-square distribution; Confidence intervals for x^2 degree of freedom.

LEARNING OUTCOMES FOR ENVIROMENTAL POLLUTION

Understand the general concept of pollution and types of environmental pollutants.

Understand the relationship between Meteorology and pollution.

Understand the quality standards and guidelines, sampling and analysis of pollution.

Understand risk assessment, prevention and control of pollution

ENVIRONMENTAL POLLUTION (BIP 124)

Concepts of pollution and types of environmental pollutions

Relationship between meteorology and pollution

Quality standards and guidelines, sampling and analysis of pollution

Risk assessment, prevention and quality control of pollution

MARINE METEOROLOGY I: (BIP 125)

1. Introduction
   - General Introduction of Marine Meteorology
   - Water coverage, Air-Sea interaction
   - Uses Marine Meteorological Information
2. Marine Meteorological Services [MMS].
   - Purpose and Principles of MMS
   - Data acquisition and Types of Data in Marine
   - Types of Sea Stations
3. Components of MMS- High seas, coastal/offshore, Port/harbor and training
4. Observation in Marine
   - Importance of Marine Observation
   - Marine Meteorological Variables: Definition, general description and importance of variables
   - Dissemination procedure of Marine Meteorological Information
5. The Ocean and current measurement

- Oceans and its Dimensions
- Hydrostatic Pressure, illumination and temperature of the ocean
- Salinity and its measurement
- Ocean current I; definition and measurement

6. Ocean Temperature
   - Sea surface temperature; Definition and uses
   - Methods of measurements
   - Diurnal/horizontal variability
   - Influences on Weather
   - Sub-surface temperature; Definition and measurement
   - Effects of temperature on marine life
7. Marine Meteorological codes and ship messages
   - Need for Codes and Marine logbook
   - Categories of ship messages
   - Coding and decoding of ship messages
8. Ocean Waves
   - Wave characteristics
   - Wave formation and growth
   - Relationship among Waves in deep and shallow waters
   - Wave measurements

LEARNING OUTCOME FOR CALCULUS

To develop the calculative skill in relation to the scientific nature of the atmosphere

DIFFERENTIAL AND INTEGRAL CALCULUS: (BIP 126)

1. Differentiation; The derivative of a function; its meaning and its determination from first principles in simple cases, e.g. x^2, 1/x; Differentiation of ax_n for integral and of sums and differences of such expressions; Gradient of a curve determined by differentiation; determination of greatest and least values; curve sketching turning points (Maxima and minima only); applications to problems involving small changes and rates of changes; Derivatives of sin x, tan x cot x, sec x and cosec x, Tangents Normals;
2. Introduction to Integration; Methods of Integration. The definite integral and its representation as an area; approximate evaluation of integrals; integration of ax_n for integral n and of sums and differences of such expressions.
3. Continuous function of a variable derived from a continuous Differential Function.
4. Differentiation of sum, difference, product and quotient of two functions; Implicit functions.
5. Differentiation of xn(n # o), trigonometric functions.
6. Compound angles.
7. Applications of Differentiation: Stationery values; maximum, Minimum and of a point of inflexion function of a variable; tangents and normal

to a curve at a point; movement of a point on a straight line, velocity and acceleration.

8. Theories on circle.
9. Partial fractions.
10. Integration: xn ,(an +b) n ,trigonometric functions and Methods of Integration.
11. Applications of integration: area under a curve; the axis of the abscissae and ordinate of the end points of the arc; lateral area and volume of a body of revolution. Application to linear motion.
12. Conic Section: the Parabola, Ellipse and Hyperbola.
13. FUNCTIONS: Functions of a real variable, limts, continuity, differentiability, Rolle's theorem, mean value theorem and leibnitz's formula.
14. Infinite series: Taylor series, Maclaurin series, convergence of power series.
15. Partial differentiation: First derivatives, function of a function, Higher order derivatives, Total derivatives and Exact differentials.
16. Line and multiple integrals: Properties of line integrals, line integrals around closed plane curves, connectivity, line integrals independent of path, properties of double integrals, properties of triple integrals, cylindrical coordinates, physical applications of triple integration.
17. Determinants: Definitions, properties of determinants, products of two determinants, Jacobians and wronskians.
18. Complex variable: Introduction, the exponential functions, circular functions and De moivre's theorem.

LEARNING OUTCOME ON PHYSICS (MECHANICS & PROPERTIES OF MATTER)

Understanding of the physical laws and its application to atmospheric science

PHYSICS (MECHANICS & PROPERTIES OF MATTER): (BIP 127)

1. Units and dimensions of physical quantities.
2. Vector and scalar quantities.
3. Linear motion of a particle: equations of motion with uniform acceleration. Newton's Laws of motion

1. Pressure.
2. Density.
3. Introduction to circular motion and Simple Harmonic Motion.
4. Oscillation and Waves.
5. Work and energy; momentum; Principles of conservation of energy;
6. Principle of conservation of momentum, coefficient of restitution
7. Dynamics of rigid bodies; moment of inertia; radius of gyration; Translational and Rotational energy; compound pendulum.
8. Motion of a body falling under gravity.
9. Friction.
10. Elasticity

11. Viscosity
12. Hydrostatics
13. Surface tension.
14. Simple harmonic motion: vibration of a spiral spring, elastic
15. string.

LEARNING OUTCOMES ON CLIMATOLOGY

- To be able to understand the elements involved in regional and local climates
- To be able to classify climates
- To be able to understand and appreciate the local climates to region of responsibility and their roles
- To be able to understand the importance of the global atmosphere and its spatio-temporal variability
- To appreciate the geographical characteristics of their area
- To be able to understand tropical disturbances and their roles in weather processes and the ITD
- To appreciate the physical processes of energy transfer from the sun to the earth surface and its application

CLIMATOLOGY (BIP 128)

1. Definition of weather and climate. Techniques usually adopted in climatology.
   Climatic controls of a place and West Africa.
   Climatic Elements.
   Climatological elements. All elements of weather should be discussed, but emphasis on those which actually shape the climate of a place e.g. temperature (including radiation), winds, pressure, sky cover, radiation, precipitation, humidity (including rainfall and air mass structure in the area).
2. The climate of Nigeria
   The ITD-Definition and its seasonal movement. Its role in determining the climate of various places in Nigeria on a meridional axis.
   The seasons in Nigeria
   The length of the rainy and dry seasons in Nigeria
   The two seasons in Nigeria; the prevailing winds and principal air masses associated with each season. Relationship between winds and air masses.
3. Weather zones in Nigeria
   Climatological characteristics of each zone. Basis for the existence of the weather zones. Meridional movement of the ITD.

4. Regional climatology: geographical distribution of climates, Climatolography. Monsoon climate with definite seasonal pattern (wet and dry tropics). Climatic Classification
   Tropical climate
   Tropical arid and semi arid climates
   Temperate climate
   Polar climate
   Tundra, taiga
   topoclimate
5. Climatic statistics and Applications
6. Climate variability and Climate Change.

LEARNING OUTCOME ON PHYSICS ELECTRICITY

- Clearly understand the concept of Potential and potential difference in both electrostatic and electric fields. Also real life application of electrostatic.
- Appreciate the nature of temporary and permanent magnets as well as connection between electric and magnetic fields.
- Understand the application of heating effects of electric current in home appliances. And also solve the real life problems in chemical cells.
- Know the principle of electromagnetic induction, dynamics and electric motors.

PHYSICS (ELECTRICITY): (BIP 131

1. Electrostatics:
   Positive and negative charges, C onductors and insulators.Coulomb Law, Permittivity, Economic importance.
2. Electric fields:
   Equipotentials, Potential due to a point charge and conducting sphere. Field Strength, electric potential, potential gradient.
3. Chemical effect of current:
   Ohm's law, resistance in series and parallel, potential difference, internal resistance and loads. Primary and secondary cells; polarization. Kirchoffs law.
4. Heating effect of current:
   Electrical energy and power.Mechanism of heating effect. Theory of heat conduction; Power rating of resistors, high tension transmission.
5. Electromagnetism:
   Magnetic field – straight wire, circular coil and solenoid.Biot -savart law. Force on a conductor; Fleming's rule, cork screw rule. Moving coil instruments; couple in a magnetic field.
6. Electromagnetic induction:
   Lenz's law; magnitude of E.M.F.; flux linkages; induction coil. Applications of Induction – Dynamos, generators and the transformer. Eddy currents; Alternating currents; back E.M.F.

LEARNING OUTCOME ON HYDROMETEOROLOGY

- To understand the components of the water cycle and its applications.

Hydro Meteorology: (BIP 132)

1. Hydrology, Hydrometeorology; Definitions and Explanations. Water bodies of the world, Role of water in Economic Activities of nations.
2. Physical: properties of water cycle on the globe: physical properties of Water; the hydrological cycle on the earth; ground water; origin and Classification of ground water; physical properties of rocks in relationship to water; physical states and movement of ground water; ground water and its relationship to rivers; confined aquifer ground water and its role in the river feeding; Lakes and reservoirs; morphology of lakes; sources of inflow to lakes; water balance of lakes; dynamic phenomena on lakes (Waves and currents).
3. Heat regime of lakes; chemical composition of lake water; biological processes in Lakes; reservoirs, their regime and water balance; swamps; formation and classification of swamps; hydrological regime of swamps; formation and movement of glaciers, their influence on river inflow and regime.
4. River system; river basins; river valleys and channels; sources of river Flow; temperature regime of rivers; regime of river stages; movement of water in rivers; flow velocity; discharge in rivers, hydrograph analysis; sediment transport; chemical composition of river water; channel formation processes; water balance and runoff; units used to measure runoff and flow; water balance and runoff units used to measure run off and flow; water balance of bodies of water.
5. Calculation of evaporation from the surface of basin;
    a. Average long-term annual runoff: distribution of annual runoff in
    b. Months and seasons; flow duration curves, mass diagrams and
    c. Storage Behaviour diagrams; maximum discharge and its calculation;
    d. Minimum flow and its calculation; sediment discharge and its calculation.
6. General alter Balance equation
7. Hydrograph Analysis Knowledge of flood regime of a stream, intelligent design of a wide. Variety of hydraulic structures such as bridges and culvert openings. Reservoir spillways and flood control works of all sorts

Remote Sensing &GIS (BIP 133)

GIS/REMOTE SENSING

1. The nature of Geographic information I
    - Maps and spatial information
    - Characterising geographic features
    - Spatial data accuracy and quality
2. The nature of Geographic information II
    - What is GIS?

- Components of a GIS
- GIS Data Model
- Spatial data relationships

3. Data Sources
   - Sources of data
   - Data input techniques
   - Data editing and quality assurance
4. Data organisation and storage
   - Organising data for analysis
   - Editing and updating of data
5. Data analysis
   - Manipulation and transformation of spatial data
   - Integration and modelling of spatial data
   - Integrated analytical function
6. Implementation issues and strategies
   - Current options and software assessment
   - Justification and expectations
   - Implementation issues
7. Development and Trends
   - New data sources
   - Hardware development
   - Software development

LEARNING OUTCOMES ON PLOTTING

- To be able to identify and interpret ICAO codes and symbols
- To be able to plot all meteorological information on weather charts

PLOTTING (BIP 134)

1. Application of models and tables.
2. Locations of station on Charts
3. Data representation on charts. Data is represented on charts with international symbols.
4. Surface Plotting model, Ship message plotting model.

LEARNING OUTCOMES FOR ENVIRONMENTAL DISASTER & RISK MANAGEMENT

1.0 Understand the concept, types and components of the environment

2.0 Understand the concepts and types of hazard.

3.0 Know the meaning and causes of disaster and risk management

4.0 Know the various disaster risk management networks and communities

ENVIRONMENTAL DISASTER & RISK MANAGEMENT (BIP 135)

1. Concept of the Environment

I. Meaning / Definition of Environment
II. Types of Environment (Physical and Human)
III. Components of Environment

2. Concept and types of Disasters/Hazards
   I. Definitions and Meaning of Hazard and Disaster
   II. Classification of Hazards
   III. Hazards Identification and Assessment
3. Impacts and Consequences of Environmental Disaster
   I. Basic classifications of environmental Disaster
   II. Causes of environmental Disaster
   III. Multiple and complex disaster
   IV. Consequences of Environmental Disaster
   V. Impacts of Environmental Disaster
4. Disaster/ Risk Managements
   I. Stages of Disaster Management
   II. Procedure for Disaster and risk Management
5. Review of disaster related Organizations
   I. Goals, Mission and vision of Organizations
   II. Contribution and location of Organizations

LEARNING OUTCOMES FOR METEOROLOGICAL INSTRUMENTS FABRICATION & CALIBRATION

1.0 Understand the concepts of fabrication and workshop safety rules

2.0 Know basic fabrication tools and how to use them

3.0 Know the processes and raw materials in fabrication

4.0 Know the essential components of a measurement system

5.0 Understand the concepts of measurement errors and uncertainty measurement

6.0 Understand the principle of calibration in measurement

METEOROLOGICAL INSTRUMENTS FABRICATION &CALIBRATION (BIP 136)

Concepts of fabrication and workshop safety rules, Essential fabrication tools used in marking out (rules, dividers, micrometer, scribers), measurement (ruler, venier, micrometer), sawing (hacksaw, piercing saw), filing (hand file, flat file, and drilling, Types of fabrication processes and techniques (e.g. cutting, bending, folding, welding, punching. Raw materials used in fabrication e.g.

plate, metal tube stock formed and expanded metal, fittings, castings, welding rods. Technological innovations in fabrication e.g. use of computer aided design and detailing system (CAD), computer aided manufacturing machinery (CAM) etc. Essential components of measurement system, measurement unit and standards, static characteristics of a measurement system (accuracy and precision, repeatability, reproducibility, tolerance, sensitivity of measurement, threshold, resolution, range or span, traceability, concepts of errors and uncertainty in measurements, principles of calibration in measurement.

OJT (BIP 137)

The OJT will be carried out for three months.

1. The Students will be divided into groups.
2. Each group will be sent to sections including Ikeja (Forecast office).
3. The students are to be supervised by the RTC instructors.
4. At the end of the OJT they are to submit their logbooks dully signed by the head of the section. And also present a written report.

TABLES OF CURRICULUM FOR BASIC INSRTUCTIONAL PACKAGE FOR METEOROLOGICAL TECHNICIAN (BIP-MT SECOND YEAR)

FIRST SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS
1	BIP 211	Urban Climatology	3	Core
2	BIP 212	Met. Statistics	3	Core
3	BIP 213	Agro Meteorology II	4	Core
4	BIP 214	Vector Analysis	3	Core
5	BIP 215	Synoptic Meteorology	3	Core
6	BIP 216	Differential Equation	3	Core
7	BIP 217	Research Methodology	3	Core

SECOND SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS
1	BIP 221	Satellite Meteorology	3	Core
2	BIP 222	Dynamic meteorology	3	Core
3	BIP 223	Introduction to Climate Change	3	Core
4	BIP 224	Atmospheric Thermodynamics	3	Core
5	BIP 225	Marine Meteorology II	3	Core
6	BIP 226	Physical Meteorology	3	core
7	BIP 227	Seminar	2	Required
8	BIP 228	OJT	4	Core

THIRD SEMESTER PROGRAMME

S/N	COURSE CODE	COURSE TITLE	UNITS	STATUS

1	BIP 231	Climate Returns	4	Required
2	BIP 232	Synoptic Weather Analysis	3	Core
3	BIP 233	Codes & Observations	3	Core
4	BIP 234	Aeronautical Meteorology II	2	Core
5	BIP 235	Project	4	Core
6	BIP 236	Field trip	3	Required

LEARNING OUTCOMES OF URBAN CLIMATOLOGY

1. Understand the concepts of local climate
2. Know the effects of topography on local climate
3. Know the effects of different surfaces on local climate

URBAN CLIMATOLOGY (BIP 211)

Introduction to kinds of local contrasts, Types of different features causing local contrasts. Influence of Topography upon the receipt of solar energy, Influence of Topography upon the general airflow at low levels Albedo and related land surfaces effects, Effects of water surfaces, Forest micro-climate.

LEARNING OUTCOMES FOR METEOROLOGICAL STATISTICS

1. Understand principles of statistical analysis for meteorological data
2. Know the methods of obtaining data and how to avoid common design flaws that lead to bias and inefficiency
3. Know how to apply fundamental concepts in exploratory meteorological/climatic data analysis.
4. Understand how to apply and interpret basic summary and modelling techniques
5. Know the basic concepts of probability and random variables in relation to weather phenomena.
6. Understand the concept of the sampling theory, foundations for classical inference involving confidence intervals and hypothesis testing.
7 Understand basic concept of some software packages for meteorological/climatic data analysis

MET. STATISTICS (BIP 212)

1.1 Explain the concept of Statistics Define the following:
   i. Data
   ii. Dispersion
   iii. Errors etc
2.1 Explain the concept of data collection
2.2 Identify different methods of obtaining data1 Define the following:
   i. Frequency distribution
   ii. Array
   iii. Range
   iv. Tally bar
   v. Class frequency

vi. Number of classes
vii. Class Interval
viii. Class Boundary
ix. Class Mark

3.2 Explain the concept of data representation

3 Calculate the following:

i. Measures of central tendency (the
ii. mean, median and mode of grouped
iii. data; quartiles, deciles and
iv. percentiles)
v. Measures of dispersion (Range,
vi. Mean deviation and standard

Deviation, coefficient of variation)

1 Explain the concept of scatter graph, regression and correlation analysis

4.2 Undertake scatter graph, regression and correlation analysis

Define and explain the concept of probability and its calculations

5.2 Explain the following:

i. Events
ii. Various types of events
iii. Trials and random variables,
iv. mathematical expectation
v. Permutations and combination.
vi. Probability distributions;
vii. (Binomial, Poisson and Normal
viii. distributions)

Compute above using meteorological data

5.2 Calculate the following:

i. Standard errors (Mean and standard deviation)
ii. Recurrence estimates
iii. Return period of extreme events

5.3Derive probabilities from various forms of events

Explain the following:

i. Meaning of sampling theory
ii. Various sampling techniques.
iii. Sampling error.
iv. Sampling distribution of means.
v. Characteristics of Student's t-
vi. distribution.
vii. Degree of freedom

6. Calculate the following:

i. Confidence intervals for sample means and sample proportions using Student's t-distribution.
ii. Chi-Square

7. Explain the following:

i. Tests of significance
ii. Null hypothesis

iii. Alternate hypothesis
iv. Type I and Type II errors.

Confidence levels of accepting or rejecting hypotheses (Null and alternate hypotheses

Describe the use of some Microsoft Office, computer packages (Word, Excel, Power point)

7. Analyze data using Microsoft Excel

AGRICULTURAL METEOROLOGY II

1. The History of Agriculture and its relationship with associated science. The relationship between Agriculture and weather elements. Weather and climatic modification for sustainable and affordable agriculture.
2. General production practice of field crops, crop production e. g Maize; Production factors for optimum yield of field crops. Factors affecting crop yield; Environment factors – rainfall, co2, temperature, Radiation, wind, light, evaporation water supply, nutrient, weed, pest and Disease soil physical condition. Plant population, Field of individual plant and community.
3. Phenology. Definition of phenology. Method of phonological observations. Different phases of phonological observation in different crop plants.
4. Agro-meteorological elements and their methods of observations. Definition, climatic elements, Biological elements, condition of observation, Agro-meteorological station and Networks, Observation of physical elements, Observation of biological Character/ Elements, Detail observation of high accuracy.
5. Climatic normal for livestock:- Poultry birds, Goat, sheep, pigs and cattle. Meteorological equivalent of crop plants for rice, sugar cane, cotton, maize, Potatoes etc. Animal production systems. Uses of animals. Outdoor animals and Meteorological elements.
6. Water and the Hydrological Cycle in Agriculture moisture characteristics of Soils water and vegetation. Determination of water loss land surface Fundamental of the evaporation process. Existing methods of determining evaporation Energy balances of estimating Evaporation Aerodynamic estimation of evaporation combination model methods of Penman and others. Development of original Penman equation. Evaporation formulae of Priestle – Taylor and Penman- Monteith special forms of precipitation Dew, snow, soil moisture Budgets – Irrigation needs.
7. Observations of crop pests and diseases, Factors affecting disease development and propagation (the role of the Macro-climatic environment namely temperature, humidity, soil pH, wind, soil Texture, etc.), Control of plant diseases (Cultural methods, Exclusion method, Eradication method, Heat and Chemical treatments of diseased plants, Biological control), Identification of Crop / plant pests and diseases. Diseases of Crop Plants (Fungal diseases, Bacterial diseases, Viral diseases), Poultry diseases (Symptoms and control)

LEARNING OUTCOMES FOR VECTOR ANALYSIS

- To develop the calculative skill in relation to the scientific nature of the atmosphere

VECTOR ANALYSIS (BIP 214)

1. Introduction-definition and examples of scalar and vector quantities, Representation of a vector; vector fields, scalar fields.
2. Vector Algebra – addition, subtraction and multiplication of vectors, the null Vector, magnitude of a vector; unit vector; law of vector algebra.
3. Components of vectors – vectors in two and three dimensions, etc.
4. Cartesian system of reference direction in two and three dimensions-Magnitude of a vector in the Cartesian system.
5. Direction Cosines – definition of, angles between two angles in Cartesian components; etc.
6. Relative vectors – position vectors, velocity acceleration vectors, Division of a line in a given ratio, co linearity of points
7. Scalar or dot product of two vectors, properties of the scalar product; special cases of the scalar product, work and scalar product
8. Vector or cross product of vectors, properties of the vector product, Applications of the vector product, Cartesian form
9. Vector equation of a straight line, position vector of a point on a circle
10. Scalar triple products and vector triple products
11. Derivative of a vector function – definition, space curve, partial derivative of Vectors, velocity vector, application of vector in mechanics
12. Gradient field, Divergence of a vector and Curl of a vector – the vector Differential operator Del, the gradient, the divergence, the curl; some Formulae involving Del.
13. Application of vectors to geometry;
14. Vector identities (reciprocal set of vectors);
15. Vector Integration.

LEARNING OUTCOMES FOR SYNOPTIC METEOROLOGY

- To Be Able To Identify Clouds And Their Associated Characteristics And Formation
- To Be Able To Understand The Importance Of The Global Atmosphere And Its Spatio-Temporal Variability
- To Be Able To Identify The Various Synoptic Features Meteorological Charts And Imageries And Their Effects
- To Be Able To Understand Tropical Disturbances And Their Roles In Weather Processes And The ITD
- To Be Able To Understand The Connection Between Tropical And Extra-Tropical Systems
- To Understand The Processes Leading To Cloud Formation And Triggering Processes/ Propagation And Regeneration

- To Be Able To Understand The Concept Of Mesoscale Systems In The Tropics
- To Be Able To Understand And Explain The Concept Of Airmasses And The Modification.
- To Be Able To Identify The Hazardous Weather Situations And Their Socio-Economic Importance To The Area Of Consideration

SYNOPTIC METEOROLOGY (BIP 215)

1. Introduction and Definition of Synoptic Meteorology.
2. ITD and the associated weather zones. Waves and jet streams, land and Sea breeze, anabatic and Katabatic winds. Evolution and Dynamics of west African line squall.
3. Tropical Weather systems. Trade inversions trade winds, Tropical/subtropical jet streams, and other broad wind systems. Rainfall, Tropical cyclones, monsoons. Characteristic patterns of cloud associated with easterly waves, seasonal evolution of the tropical wind systems, and the inter-tropical convergence zone; annual cycles.
4. Mid-latitude synoptic systems. Air-mass concept; source areas; formation processes for air-masses. Air-mass modification; thermodynamic and dynamic changes; boundary/interface between two adjacent air masses; the slope of steady-state frontal zones; frontal-wave depression.
5. General circulation

LEARNING OUTCOMES ON DIFFERENTIAL EQUATION

To develop the calculative skill in relation to the scientific nature of the atmosphere

DIFFERENTIAL EQUATION (BIP 216)

1. Differentiation and integration of simple functions, exponential functions, logarithmic functions and inverse trigonometric functions.
2. Partial derivatives; total differential and total derivatives.
3. Ordinary differential equations: equations of first order and degree; equation of higher degree; homogeneous and inhomogeneous equations.
4. Partial differential equations: linear partial differential equations of first and second order dent variables; the wave equation in one dimension; the vibrating string; normal modes of vibration and heat equation.

LEARNING OUTCOME FOR RESEARCH METHODOLOGY

- Introduce students to what research is all about.
- Gain in depth knowledge in step by step way of doing research.
- Get exposed to different methods of data collection in research and methods of data analysis.

- Students will be able to know how to do to project

RESEARCH METHODOLOGY (BIP 217)

Course Outline:

- ✓ Meaning of research or concept of research
- ✓ Types of research
- ✓ Classification of research
- ✓ Characteristics of researcher
- ✓ Values of Research
- ✓ Ethical issues in research
- ✓ Research format: This is divided into:
  1. Projects preambles or preliminaries
  2. Introduction
  3. Conceptual or theoretical frame work and literature review
  4. Methodology
  5. Results and discussions
  6. Summary, conclusion and recommendations
  7. References

LEARNING OUTCOMES ON SATELLITE METEOROLOGY

- To be able to identify hydrometeors and their method of observation
- To be able to conduct necessary observations and understand the techniques
- To be able to identify the various synoptic features of meteorological charts and imageries and their effects
- To be able to identify clouds and their associated characteristics and formation

SATELLITE METEOROLOGY (BIP 221)

1. Basics in remote sensing Physics behind remote-sensing
2. Introduction to History of meteorology satellites
3. Satellites-data acquisition, processing and archiving
4. Satellite orbits, characteristics and radiometers
5. Satellite data acquisition, processing and data management.
6. Satellite image analysis, display and interpretation
7. Application of satellite imagery both in the visible and infrared
8. Regions for the analysis and interpretation of weather systems.
9. Case-studies, that is, a series of practical examples to examine a range of Meteorological events over the African continent, tropics and mid-latitude with emphasis on the application of satellite Meteorology to public weather forecast, Aeronautical Meteorology and Agro-meteorology.
10. Future of satellites meteorology

LEARNING OUTCOME ON DYNAMIC METEOROLOGY

- To be able to identify the hazardous weather situations and their socio-economic importance to the area of consideration

- To be able to understand the concept of mesoscale systems in the tropics
- To understand the concept of air flow and its role of wind and its effect to weather development
- To be able to understand and explain the concept of airmasses and the modification.
- To be able to understand the connection between tropical and extra-tropical systems

DYNAMIC METEOROLOGY (BIP 222)

1. Concept of dynamic meteorology compared with synoptic and Physical Meteorology, physical dimensions and units.
2. Atmospheric scales; pressure gradient, gravitational, centrifugal, gravity and coriolis forces, equation of motion in a simple form, geostrophic wind, wind and pressure near the equator; gradient wind and comparison with geostrophic wind, trajectories and streamlines, cyclostrophic wind; flow within the planetary boundary layer (cross-isobaric flow)
3. Ageostrophic and Isallobaric winds. Hydrostatic equilibrium and Hypsometric equation and uses. Thermal wind, divergence, convergence and vertical motion. Intensification and deepening of pressure systems. Vorticity (relative and absolute). Formation of cyclones and anti cyclones. Turbulence and gustiness, eddies and vertical transport of matter, clear-air turbulence.

LEARNING OUTCOMES ON INTRODUCTION TO CLIMATE CHANGE

To understand the concept of climate change studies

INTRODUCTION TO CLIMATE CHANGE (BIP 223)

1. Introduction**:** The concept of climate: Climate variation and Climate change.
2. The Climate System**:** How climate is generated, components of the climate system, i.e the atmosphere, the lithosphere, the oceans, the cryosphere and the biosphere.
3. History of climate change
4. Theories of possible causes of climate change**:** Terrestrial theories; Astronomical theories; Extra-terrestrial theories; the Global warming debate.
5. Potential impacts of global warming and climate change: Impacts on agriculture and land use; impacts on the ecosystems and biodiversity; impacts on human settlements; impacts on human settlements; impacts on diseases and health and impacts on hydrology an d water resources.
6. Vulnerability to climate change: The concept of vulnerability; assessing vulnerability to climate change and reducing vulnerability to climate change.
7. Response strategies to climate change: Climate change mitigation strategies; climate change adaptation strategies; climate change and

coastal zone management; climate change – water management and agriculture.

8. The Climate prediction**:** Weather prediction and climate prediction methods and problems of climate prediction. Future weather and climate- the way forward.

LEARNING OUTCOMES ON ATMOSPHERIC THERMODYNAMICS

- Understanding of the physical laws and its application to atmospheric science
- To be able to identify the various synoptic features meteorological charts and imageries and their effects
- To understand movement of air constituents

ATMOSPHERIC THERMODYNAMICS (BIP 224)

1. Introduction to thermodynamics System
2. Gas laws - Boyle's and Charles' Laws, Dalton's Law of partial pressures, Ideal gas law. Equation of state for dry and moist air, Mixture of gases. Kinetic theory of gases.
3. Adiabatic processes. Definitions, Dry, Moist and Pseudo – adiabatic processes. Equations for adiabatic processes, Dry, moist and saturated adiabatic lapse rates. Poisson equation and potential temperature. Latent heat of condensation. Comparison of magnitudes of different lapse rates. Methods of determining stability – parcel and slice methods. Hydrostatic balance, Potential energy, Geopotential meter and geopotential height.
4. Conservation of energy and the first law of thermodynamics. Change of phase and latent heat. Reversible and irreversible processes.
5. Hydrostatic stability and Convection.
6. Moisture variables. Definitions and meanings of Potential temperature, vapour pressure, mixing ratio, absolute humidity, equivalent potential temperature, saturation mixing ratio, absolute humidity, dew point temperature, specific humidity, virtual temperature etc.
7. Thermodynamic cycle. Carnot cycle, Isothermal and adiabatic expansion and compression.

MARINE METEOROLOGY II (BIP 225)

1.PHYSICAL PROPERTIES OF THE SEA WATER –

- Density, heat capacity, diffusion and

- Mixing properties of the ocean.

2. DYNAMICS OF THE UPPER OCEAN –
   - Gravity - density – pressure,
   - Ocean currents II
   - Thermohaline Circulation
   - Upwelling and its effects
3. PLATFORMS AND INSTRUMENTS

- Observation Techniques – In situ/Remote sensing

- Visual and instrumental measurements of Marine Parameters

4. LINEAR AND NON-LINEAR WAVES THEORY

   Waves in oceanic waters

   - The general key concept
   - Wave spectrum,
   - Wave dynamic and transport

   Waves in coastal waters

   - The general key concept
   - Wave propagations
   - Tidal waves

5. FORECASTING TECHNIQUES IN MARINE ENVIRONMENT-
   - Models and Satellite applications

- Forecasting Tools.

6. OCEANIC HAZARDS– Storm surge, Tsunamis etc
   - Causes, impacts and management.

LEARNING OUTCOMES ON PHYSICAL METEOROLOGY

- To understand movement of air constituents
- To be able to identify clouds and their associated characteristics and formation
- To understand the processes leading to cloud formation and triggering processes/ propagation and regeneration
- To understand their formation and effect in the hazardous weather
- To appreciate the concept of atmospheric phenomenon
- To be able to identify hydrometeors and their method of observation

PHYSICAL METEOROLOGY (BIP 226)

1. Introduction to the subject
2. Definitions, Clouds, Fog and precipitation. Basic knowledge of their Formation. Fog classification and artificial rain, visibility, meteors.
3. Influence of the surface tension of rain drops and of the hygroscopicity of the nuclei on saturation pressure;
4. Process of raindrop formation.
5. Cooling of the air due to adiabatic and non-Adiabatic processes.
6. Cloud structure and evolution dynamics.
   i. Frontally generated cloud
   ii. Cumuliform clouds
   iii. Orographic clouds
   iv. International cloud classification
7. Static Electricity and Electrostatic phenomenon -
   i. Elements of Atmospheric Optics and Electricity, Refraction, rainbow, Halo, Corona Blue sky.

ii. Transparency of the atmosphere. Types of atmosphere – Constant lapse rate, Homogenous, Isothermal and Adiabatic.
iii. Relationship between static electricity and atmospheric phenomena.
iv. Lightning discharge and thunderstorms.

SEMINAR (BIP 227)

Pre data presentation by the students on their individual topics

LEARNING OUTCOMES ON CLIMAT RETURNS

- Ability to collate and archive climatic data for research purposes

OJT (BIP 228)

It is a skills training programme designed to give students first experience in a working environment to complement the theoretical learning. It equip the students with qualities of leadership and integrity.

The OJT will be carried out for three months.

1. The students will be divided into groups.
2. Each group will be sent to sections/units of the Agency within Lagos including Ikeja (Forecast office).
3. The students are to be supervised by the RTC instructors.
4. At the end of the OJT they are to submit their logbooks dully signed by the head of the section. And also present a written report.

LEARNING OUTCOME ON PROJECT
By the end of the training the students will be able to;

a. Apply their knowledge in real work situation thereby bridging the gaps between theory and practice.
b. Acquire interpersonal skills by meeting with professional in the field of study.

CLIMAT RETURNS (BIP 231)

. CLIMATOLOGICAL RETURNS: (BIP 213)

1. Climatological returns; its meaning; importance; qualities;
   Types of forms; Form Met.100; Form Met. 101, Form Met. 102; Form Met. 103, Form Met. 104; Form Met. 113; Form Met. 120; Form Met. 130; Form Met. 131; Form Met. 135; Form Met. 141l, Form Met. 143; Form Met. 145; Form Met. 146; Form Met. 147; Form Met. 509; Form Met. 4520; Form Met. 4521; Form Met.4522; Compilation; Computation;
2. Climatological returns forms and usage
   Autographic chart analysis and entries into appropriate form
   Extraction of meteorological data from climatological returns
   Checking of climatological returns.

LEARNING OUTCOMES ON SYNOPTIC WEATHER ANALYSIS

- To be able to identify and understand the principle behind the formation and associated weather events
- To be able to understand the concept of weather developments at different scales over point location
- To be able to identify the various synoptic features, meteorological charts and imageries and their effects
- To be able to identify the various synoptic features meteorological charts and imageries and their effects
- To be able to evaluate the recent technology used for the display of weather systems, their benefits and shortcomings

SYNOPTIC WEATHER ANALYSIS (BIP 232)

1. Definition of various Isolines
2. Rules governing Analysis/Nature of Analysis
3. Types of Charts used in Analysis
4. Analysis of various elements (Surface and Upper Air)
5. -Temperature, Wind, Humidity, Dew point, Divergence, Vorticity etc
6. Introduction to Numerical weather Prediction
7. Tephigram: Analysis & Interpretation.

LEARNING OUTCOME ON CODES & OBS II

Understand the supplementary messages, modifications and corrections to synoptic, METAR and SPECI messages**.**

CODES & OBSERVATION II (BIP 233)

Introduction to "9" special phenomenon groups i.e. 9spspspsp of synoptic message

Introduction to supplementary information groups of synoptic message e.g 5j1j2j3j4, 4ffff, 55408, 4esss etc

Section 5 555 of synoptic message e.g. 1sntxtxtx 2sntntntn 30uuu 4rrrr

METAR modifications and corrections

SPECI modifications and corrections

Prevailing visibility/ directional visibility

LEARNING OUTCOMES FOR AERONAUTIC METEOROLOGY II

- Familiarize students to terminologies in aeronautical meteorology.

- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to issue aviation reports for safety of aircrafts
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

AERONAUTICAL METEOROLOGY II (BIP 234)

Terminal Aerodrome Forecasts (TAFs)

Aerodrome warnings

Windshear warnings

Significant Meteorological Information (SIGMET

Weather Briefing and flight documentations

Area Forecasts

LEARNING OUTCOMES ON PROJECT

- To be able to explain and analyse specific weather phenomenon/ variables and produce findings, conclusions and recommendations

PROJECT (BIP 235)

Students may choose a title of his/her project work with relevance to Meteorology/related field and to be supervised by RTC instructor. There is going to be an oral presentation defence of the project and to be graded alongside with the class work. Once the project is completed, students are to submit three bound finished copies to the office of program Director. The colour of the project cover is green.

FIELDWORK: (236)

This is a week study of meteorological, hydrological and geographical phenomena that influence weather and climate. Impact of weather and climate on Agriculture, Water Resources, coastal areas, tourism and desertification are studied. While NIMET takes care of transportation and accommodation of Staff and Students, the Students will take care of their feeding. This study will take place in any part of the Country or West African Sub-region

Meteorological Forecasting Course (Formerly Meteorological Technicians Course – Senior level)

The above course is a straight one year programme.

Under the semester arrangement it has been broken down into 3 semesters by the RTC to foremost have pre-requisite courses in the earlier semesters such as to empower the students academically in subsequent semesters.

FIRST SEMESTER

S/N	COURSE CODE	COURSE NAME	COURSE STATUS	UNIT(S)
1	BIP 311	Research Methodology	Compulsory	3
2	BIP 312	Aeronautical Meteorology	Compulsory	4
3	BIP 313	Statistics	Compulsory	3
4	BIP 314	Calculus	Compulsory	3
5	BIP 315	Satellite Meteorology	Compulsory	3
6	BIP 316	Marine Met. II	Compulsory	2

SECOND SEMESTER

S/N	COURSE CODE	COURSE NAME	COURSE STATUS	UNITS
1	BIP 321	Differential Equations	Compulsory	4
2	BIP 322	Physical Meteorology	Compulsory	3
3	BIP 323	Climatology	Compulsory	3
4	BIP 324	Synoptic Meteorology	Compulsory	3
5	BIP 325	Synoptic Meteorological Practicals	Compulsory	4
6	BIP 326	OJT	Compulsory	4

THIRD SEMESTER

S/N	COURSE CODE	COURSE NAME	COURSE STATUS	UNITS
1	BIP 331	VECTOR ANALYSIS	COMPULSORY	3
2	BIP 332	METEOROLOGICAL THERMODYNAMICS	COMPULSORY	4
3	BIP 333	DYNAMIC METEOROLOGY	COMPULSORY	4
4	BIP 334	AGRICULTURAL METEOROLOGY	COMPULSORY	3
5	BIP 335	HYDROMETEOROLOGY	COMPULSORY	3
6	BIP 336	ORAL ASSESSMENT	COMPULSORY	3
7	BIP 337	PROJECT	COMPULSORY	4
			TOTAL	59

Synopsis for each course by Semesters

1ST SEMESTER SYNOPSIS

RESEARCH METHODOLOGY BIP 311 - (3UNITS)

Course Outline:

- ✓ Meaning of research or concept of research
- ✓ Types of research
- ✓ Classification of research
- ✓ Characteristics of researcher
- ✓ Values of Research
- ✓ Ethical issues in research
- ✓ Research format: This is divided into:
    1. Projects preambles or preliminaries
    2. Introduction
    3. Conceptual or theoretical frame work and literature review
    4. Methodology
    5. Results and discussions
    6. Summary, conclusion and recommendations
    7. References

LEARNING OUTCOME ON RESEARCH AND METHODOLOGY

To be able to apply research skills and methods in a research project work

AERONAUTICAL METEOROLOGY - BIP 312 (4UNITS)

1. General Aviation Services.
2. Brief history of aviation and aeronautical meteorology. Operation aspects. Flight preparation. Flight plan. Meteorological service.
3. Hazardous Phenomena
4. Aircraft Icing, fog, Turbulence, Volcanic ash: Their formation of icing, elementary knowledge of icing types, accretion rates and association of icing with cloud (stratiform and cumuliform clouds), freezing precipitation, orographic and frontal lifting.
5. Thunderstorms:Formation conditions, types of thunderstorm. The thunderstorm cell, aviation hazards, squall line thunderstorm hazards, hail hazards, hail formation, hail prediction and prevention lightning. Avoidance of thunderstorms.
6. Wind Shear: Low-level wind shear associated with marked inversion and/or low-level jet streams. Winds shear in the approach and landing phases of flight. Topographic winds shear.
7. Meteorological service for International Air Navigation
8. Terminology. Area forecast centres. Aeronautical meteorological offices. Aeronautical meteorological stations. Observations made at
9. Aeronautical meteorological stations. Meteorological reports from aeronautical meteorological stations. Aviation routine weather report (MET Report and METAR). Aviation selected special weather report (SPECIAL and SPECI). Aerodrome forecasts. Forecasts for take-off. Landing forecasts (trend type).

10. Wind shear and Aerodrome warnings. GAMET area forecast, SIGMET and AIRMET (information). Route forecast. Dissemination of meteorological information. Information for and from air traffic services. Forms of meteorological messages. Information for search and rescue. Aeronautical climatological information.
11. Information for operations' local representatives. Information requires from operators. Information for pilots-in-command prior to departure. Information for pilots-in-command during flight. Debriefing.
12. Definitions should include:

Meteorological report, observation. Visibility, runway visual ranges. Altitude, elevation, height, aerodrome, flight-level transitional level. Aerodrome minima, instrument runway, landing forecast, aerodrome forecast, GAMET area forecast, SIGMET and AIRMET (information). Briefing route and special air-report, operator, operator's local representatives and pilot-in-command.

13. Operation of Aircraft

Flight planning: Definition, flight planning services, sources of meteorological information, available meteorological information, flight planning requirements and significance of meteorological information. Duties of flight operation officers when exercising operational control. Principles of flight. Air density and aircraft performance. Standard atmosphere. Density altitude other factors affecting aircraft performance. Fuel consumption. Radio meteorology. Effects of meteorological phenomena on ground communications. General flight navigation. Air pilotage. Electronic navigation. Celestial navigation. Aids to approach and landing. Flight planning aspects. Aerodrome meteorological minima.

14. Aeronautical telecommunications

Understanding the general organization of aeronautical telecommunication; Operation of the Aeronautical Fixed Service including particularly the Aeronautical Fixed Telecommunication Network (AFTN), Aeronautical Telecommunication Network (ATN); message headings, addressing of messages, priorities of messages, ICAO abbreviations used in messages; regional aeronautical MET telecommunication procedures (AMBEX, ROBEX); satellite distribution system for information relating to air navigation (SADIS) and international satellite communications system (ISCS). Other systems should include: Meteorological Data Distribution

(MDD), RETIM (SYNERGIE-PC), SATCOM,

Primary Data User System (PDUS), MESSIR-VISION, MESSIR-COM, the Global Telecommunication System (GTS) and all latest available systems or facilities.

15. Air Traffic Services

Definitions. Flight rules. The nature of air traffic services. Air traffic control service. Area control service. Approach control service. Aerodrome control service.

16. WMO and ICAO Documentation: Technical Regulations, (WMO-No.49), Vol.II – Meteorological service for International Air Navigation. Manual on codes (WMO-No.306). Guide on Meteorological Observation and Information Distribution System at Aerodrome (WMO-No.731). Guide to practices for Meteorological Offices Serving Aviation (WMO-No.732). Guide to .Meteorological instruments and Methods of observation (WMONo.8). Weather Reporting (WMO-No.9).

LEARNING OUTCOME ON AERONAUTICAL METEOROLOGY

- To be able to determine the products and services that are generated and how to sell them to the public
- To familiarize the students with the functions of the national meteorological services

STATISTICS- BIP 313 (3UNITS)

1. Graphical representation of data; finding the mean, median and mode of grouped data; Quartiles, percentiles, deciles etc.
2. Regression and Correlation
3. Scatter graphs, Relationships between two variables and scatter graphs (construction, line of best fit, and estimate from scatter graphs significance of the scatter graph, limitations of scatter graph) computing regression lines equation; method of least squares, measuring the deviation; the regression of y on x; graphing regression lines; the use of regression lines; choice of regression line and regression coefficient.
4. Correlation (computation of r; interpretation of r; types of correlation; Rank correlation r^1; the equation of a least square line and fitting the data; Multiple linear regression and non-linear regression.
5. Probability

Conditional probability; independent and dependent evens; mutually exclusive events; Mathematical expectation; permutations and combinations. Probability distributions, the binomial distribution, the Poisson distribution, Properties of the

Normal distribution. The relation between binomial and normal distribution.

6. Estimation

Tests of significance; testing a hypothesis; the null hypothesis, testing the null hypothesis, rejecting of the null hypothesis, non-rejection of the null hypothesis, confidence level. Venn diagrams.

LEARNING OUTCOME ON STATISTICS

To analyse and interpret climatic data

CALCULUS - BIP 314 (3UNITS)

1. FUNCTIONS: Functions of a real variable, limits, continuity, differentiability, Rolle's theorem, mean value theorem and leibnitz's formula.
2. INFINITE SERIES: Taylor series, Maclaurin series, convergence of power series.
3. PARTIAL DIFFERENTIATION: First derivatives, function of a function, Higher order derivatives, Total derivatives and Exact differentials.
4. LINE AND MULTIPLE INTEGRALS: Properties of line integrals, line integrals around closed plane curves, connectivity, line integrals independent of path, properties of double integrals, properties of triple integrals, cylindrical coordinates, physical applications of triple integration.
5. DETERMINANTS: Definitions, properties of determinants, products of two determinants, Jacobians and wronskians.
6. COMPLEX VARIABLE: Introduction, the exponential functions, circular functions and De moivre's theorem.

LEARNING OUTCOME FOR CALCULUS

To develop the calculative skill in relation to the scientific nature of the atmosphere

SATELLITE METEOROLOGY- BIP 315 (3UNITS)

1. Basics in remote sensing Physics behind remote-sensing
2. Introduction to History of meteorology satellites

3. Satellites-data acquisition, processing and archiving.satellite orbits, characteristics and radiometers. Satellite data acquisition, processing and data management.

4.Satellite image analysis and interpretation

Satellite image analysis, display and interpretation

Application of satellite imagery both in the visible and infrared Regions for the analysis and interpretation of weather systems.

4. Case-studies, that is, a series of practical examples to examine a range of Meteorological events over the African continent, tropics and mid-latitude with emphasis on the application of satellite Meteorology to public weather forecast, Aeronautical Meteorology and Agrometeorology.
5. Future of satellites meteorology

LEARNING OUTCOME ON SATELLITE METEOROLOGY

- To be able to identify hydrometeors and their method of observation
- To be able to conduct necessary observations and understand the techniques
- To be able to identify the various synoptic features of meteorological charts and imageries and their effects
- To be able to identify clouds and their associated characteristics and formation

MARINE MET. II (316)

1.PHYSICAL PROPERTIES OF THE SEA WATER –

- Density, heat capacity, diffusion and

- Mixing properties of the ocean.

1. DYNAMICS OF THE UPPER OCEAN –
   - Gravity - density – pressure,
   - Ocean currents II
   - Thermohaline Circulation
   - Upwelling and its effects
2. PLATFORMS AND INSTRUMENTS

   - Observation Techniques – In situ/Remote sensing

   - Visual and instrumental measurements of Marine Parameters

3. LINEAR AND NON-LINEAR WAVES THEORY

   Waves in oceanic waters

   - The general key concept
   - Wave spectrum,
   - Wave dynamic and transport

   Waves in coastal waters

   - The general key concept
   - Wave propagations
   - Tidal waves

4. FORECASTING TECHNIQUES IN MARINE ENVIRONMENT-
   - Models and Satellite applications

- Forecasting Tools.

5. OCEANIC HAZARDS– Storm surge, Tsunamis etc
   - Causes, impacts and management.

2ND SEMESTER SYNOPSIS

DIFFERENTIAL EQUATIONS- BIP 321 - (4UNITS)

1. Differentiation and integration of simple functions, exponential functions, logarithmic functions and inverse trigonometric functions.

2. Partial derivatives; total differential and total derivatives.

3. Ordinary differential equations: equations of first order and degree; equation of higher degree; homogeneous and inhomogeneous equations.

4. Partial differential equations: linear partial differential equations of first and second order dent variables; the wave equation in one dimension; the vibrating string; normal modes of vibration and heat equation.

PHYSICAL METEOROLOGY BIP 322 - (3UNITS)

The sun, earth and electromagnetic radiation. Features of the Sun, motions of the Earth; seasons; duration and intensity of sunshine ; solar radiation; types of heat transfer radiant energy and light; blackbody radiation; emissivity, absorptivity and trasmissivity. Qualitative discussion of radiation laws Kirchhoff, Plank, Stetan-Bolzman, Wien; scattering; absorption of the radiant energy in the atmosphere; albedo of natural surfaces; upper surface of clouds, land surfaces, water greenhouse effect. The heat balance of the atmosphere; terrestrial radiation; the free atmosphere radiation; radiation flux; the earth heat balance.

Introductory atmospheric thermodynamics. Vertical structure of the atmosphere; Distribution of temperature and pressure; troposphere; stratosphere; tropopause; upper atmosphere; adiabatic process hydrostatics balance; geopotential; The laps rate; vertical stability.

Atmospheric moisture; condensation process. Water vapour; change of phase; vapour pressure; saturation; absolute and specific humidity;relative humidity; temperature of dew point. Change of phase; adiabatic process at saturation; reversible adiabatic and pseudo adiabatic condensation process; formation of clouds and precipitation; wetbulb temperature;

thermodynamics diagrams; tephigram; conditional and convective instability.

Atmospheric motion; geostrophic flow. Atmospheric pressure; gravity; pressure gradient force; hydrostatic balance; carioles forces; geostrophic wind; variation of wind and temperature with height; upper winds; frictional force. Orographic effects; local winds; convection; elements of atmospheric turbulence.

Element of atmospheric optics and electricity. Atmospheric refraction, rainbow, halo, corona, blue of the sky; transparency of the atmosphere and visibility; air conductivity, lightning discharge and thunderstorms.

Energy balance of the upper atmosphere; photo ionization; photo dissociation of oxygen; ozone layer.

Cloud and precipitation; water cycle Evaporation; condensation and sublimation; saturation vapour pressures over liquid and solid; relative and specific humidity; suspended particles. Formation of fogs, mist and cloud; cloud condensation nuclei. Growth of a drop by condensation cloud droplets growth by collision and coalescence.

LEARNING OUTCOME ON PHYSICAL METEOROLOGY

To enable the students understand the physical processes of energy transfer from the sun to the earth surface.

CLIMATOLOGY- BIP 323 (3UNITS)

1. General climatology, notion of climate, definition of climate physical factors of climate, importance of heat, radiation and humidity in climatology.
2. Astronomical and geographical factors: notion of solar climates; influence of latitude environmental influence on climate; effects of distribution of sea and land; degree of continentality; effects of water masses
3. Climatic elements: mean climatic elements, classification, representation (mean, sum, frequency, normal, and variability), instruments and method of observation for various climatic elements.
4. Physical climatology: notion relating to the radiation, heat, energy and water balances, elementary notions on diffusion and turbulence; comparison of normal values and variability of climatic elements at the various latitude.
5. Dynamical climatology: general atmospheric circulation; centers of activity and types of climate associated with them;

climatologically aspects ofdynamical meteorology; representation of climatologically data.

6. Synoptic climatology: grouping of climatic elements according to the nature of the air masses; mean or frequency of climatic elements associated with types of weather; geographical distribution of fronts; frontal zones and air masses and climatological phenomenon associated with them. Regional meteorology: description of the climate of the globe; climatology of the region or country where the training is given qualitative description, numerical data, maps and atlases.
7. Meso and micro climatology: general principles, concepts and definitions; examples of microclimates.
8. Bioclimatology: general principles, concepts and definitions; bioclimatology related to the various human activities and associated fields.
9. Applied climatology: general notions on the application of climatology to the various human activities (agriculture, aeronautics, marine, public work, transport ,etc.), Climatic changes: basic notions
10. Special climatological methods: climatological statistics: emphasis is on the practical aspects.
11. Machine processing of climatological data: punched cards, magnets tapes, punched tapes; use of computer: programming (principles and simple application).

SYNOPTIC METEOROLOGY- BIP 324 - (3UNITS)

1. West African line squalls

Definitions, formation, structure, propagation and maintenance. In-situ development, deep mesoscale convection systems. Importance to national economy.

2. Harmattan dust haze

Definition, concept of plume, Mechanics of dust raising and transportation. Role of gravity in dust deposition, Clearance of dust haze, Frequency of dust spells. Behaviour of Saharan high pressure cell and mid- latitude trough, Dust particles as pollutants. Economic aspects in relation to human health, aviation and other sectors of the economy.

3. Monsoons

Theory of global monsoon circulations. West African Monsoons- onset, maintenance, cessation and failure, Baroclinicity, energetics and vertical wind profile. Consequences of late onset and failure.

4. Little Dry Season (LDS)

Definition, period of occurrence and area affected. Associated synoptic features, Aspects of divergence, vorticity and intensity. Critical temperature for onset and cessation.

Atmospheric general circulation

One and three cellular models, Hadley and Ferrell cells, Establishment of wind and pressure systems globally. Energy exchange, creation of solenoidal fields. Application of Monsoons tilts at troughs and

Redistribution of Meteorological quantities. Angular momentum balance.

5. African waves

Origin and formation, structure, dynamics and stability criteria. Evolution of weather types.

6. Forcing function in West African

Definition, concept of forcing functions. Influence of various forcing functions over West Africa. Location and structure of forcing functions e.g. African Easterly Jet (AEJ).

7. Frontal systems

Mid-latitude and polar fronts. Cold front, warm front and occlusion. Association weather and synoptic features, Linkage with tropical systems.

Dynamics of frontal systems.

8. Inter-tropical Discontinuity (ITD)

Definition and characteristics. Dynamics, the three-dimensional structure, Association weather zones and concept of monsoon trough.

9. Wide-spread wet spells;

Low level convergence and upper level divergence. Condition for sustained vertical motion. Circulation in vertical planes and solenoidal field.

10. West African Jets;

African Easterly Jet – Location, existence period, structure, dynamics and influence on propagation storms. Tropical Easterly Jet – structure, dynamics, period of existence, location and influence on weather.

LEARNING OUTCOME ON SYNPOTIC METEOROLOGY

- To be able to understand and explain the concept of airmasses and the modification.
- To be able to identify the various synoptic features meteorological charts and imageries and their effects

SYNOPTIC METEOROLOGICAL PRACTICALS - BIP 325 (4UNITS)

1. Definition of Analysis
2. Composition/Design of various Charts
3. Types of elements and the charts used
4. Rules governing Analysis/Nature of Analysis
5. Types of Analysis and available
   Surface
   Upper Air
   7. Frontal
6. Importance of the above to science of Meteorology
7. Practical Exercise
8. The use of PDUS, AFDOS, Messir vision and Radar in Meteorology and Global Model Charts
9. Synoptic Systems Theory
10. Dust Haze, Fog, Thunderstorms/Line Squall

LEARNING OUTCOME ON SYNOPTIC METEOROLOGICAL PRACTICALS

- To Understand The Principles Behind The Formation And Associated Weather Events
- To Be Able To Appreciate The Concept Of Weather Developments At Differennt Scales Over Point Location
- To Be Able To Identify The Various Synoptic Features Meteorological Charts And Imageries And Their Effects
- To Be Able To Eveluate The Recent Technology Used For The Display Of Weather Systems, Their Benefits And Shortcomings
- To Be Able To Describe Processes And Principles Of NWP As Well As Interpreting NWP Products

OJT- BIP 326

It is a skills training programme designed to give students first experience in a working environment to complement the theoretical learning. It equip the students with qualities of leadership and integrity.

The OJT will be carried out for three months.

5. The students will be divided into groups.
6. Each group will be sent to sections/units of the Agency within Lagos including Ikeja (Forecast office).
7. The students are to be supervised by the RTC instructors.

8. At the end of the OJT they are to submit their logbooks dully signed by the head of the section. And also present a written report.

LEARNING OUTCOME ON PROJECT

By the end of the training the students will be able to;

a. Apply their knowledge in real work situation thereby bridging the gaps between theory and practice.

b. Acquire interpersonal skills by meeting with professional in the field of study.

3RD SEMESTER SYNOPSIS

VECTOR ANALYSIS – VECTOR ALGEBRA AND VECTOR CALCULUS BIP 331- (3UNITS)

1. Introduction-definition and examples of scalar and vector quantities, Representation of a vector; vector fields, scalar fields.
2. Vector Algebra – addition, subtraction and multiplication of vectors, the null Vector, magnitude of a vector; unit vector; law of vector algebra.
3. Components of vectors – vectors in two and three dimensions, etc.
4. Cartesian system of reference direction in two and three dimensions. Magnitude of a vector in the Cartesian system.
5. Direction Cosines – definition of, angles between two angles in Cartesian components; etc.
6. Relative vectors – position vectors, velocity acceleration vectors, Division of a line in a given ratio, co linearity of points
7. Scalar or dot product of two vectors, properties of the scalar product; special cases of the scalar product, work and scalar product
8. Vector or cross product of vectors, properties of the vector product, Applications of the vector product, Cartesian form
9. Vector equation of a straight line, position vector of a point on a circle
10. Scalar triple products and vector triple products
11. Derivative of a vector function – definition, space curve, partial derivative of Vectors, velocity vector, application of vector in mechanics

12. Gradient field, Divergence of a vector and Curl of a vector – the vector Differential operator Del, the gradient, the divergence, the curl; some Formulae involving Del.
13. Application of vectors to geometry;
14. Vector identities (reciprocal set of vectors);
15. Vector Integration.

LEARNING OUTCOME ON VECTOR ANALYSIS

To Develop the Calculative Skill In Relation To the Scientific Nature of the Atmosphere.

METEOROLOGICAL THERMODYNAMICS - BIP 332 (4UNITS)

1. Object of thermodynamics; thermodynamic system – definition, exchanges of energy and matter with the external world; closed and open systems; physical state of a system, variables of state, (p.v) systems, Clapeyron's diagram.

2. Temperature scales (Celsius, Fahrenheit, Kelvin); variables of state and the equation of state of a system; homogenous and non-homogenous system; thermal expansion of solids, liquids and gases – the laws of Boyle Mariotte, GayLussac, Avogadro and Dalton (gas mixtures); equation of state of a gas – perfect gas and van deer Waals' gas.

3. Definition of heat, quantity of heat, calorie, thermal conductivity, specific heat, case of gases, heat of change of phase, heat of reaction; calorimetric.

4. First law of thermodynamics; various forms of energy (work, heat, electricity, chemical, etc.); principle of conservation of energy; principle of the equivalency of heat and work (joule); internal energy, enthalpy; work accomplished by the expansion of an ideal fluid; reversible exchange of work and heat; adiabatic transformation, case of perfect gas.

5. Second law of thermodynamics

Entropy of a system, Entropy change as a function of potential temperature. Irreversibility –concept of statement of second law of thermodynamics.

LEARNING OUTCOME ON METEOROLOGICAL THERMODYNAMICS

- To Understand Movement Of Air Constituents
- To Be Able To Describe Processes And Principles Of Nwp As Well As Interpreting Nwp Products

DYNAMIC METEOROLOGY- BIP 333 (4UNITS)

1. Atmospheric scales, Discussions on pressure gradient, gravitational, frictional, centrifugal, Gravity and carioles forces, total local derivatives, transformation from non-rotating co-ordinate system; equation of motion and vector form as derived from Newton's second law, Equation of motion in spherical co-ordinates (tangent plane approximation); scale analysis leading to simplified equations.

2. Introduction to hydrostatic approximation, justification for this approximation, equation of quasi-hydrostatic motion using pressure as vertical co-ordinate.
3. Horizontal balanced motions, motion with no tangential acceleration, geostrophic and gradient wind relations, comparison of geostrophic and gradient wind, geostrophic thermal wind, streamlines and trajectories, barotrophic and baroclinic atmosphere, thermodynamic energy equation, continuity equation, divergence of three dimensional and horizontal wind fields, vertical motion, vortices and circulation, Bjeknes' circulation theorem, introduction to stream friction and velocity potential, Rossby long waves, brief description of the baroclinic waves and baroclinic instability.
4. Angular momentum of the atmosphere about the earth's axis; relative and absolute momentum; balance of angular momentum; meridional transport by atmospheric disturbances; relation between this transport and zonal circulation; the balance of the atmospheres' kinetic energy internal energy; production, destruction and transport of energy; role of Baroclinicity; the energy circle of the general circulation; influence of oceans, continent and large scale orographic features on general circulation.
5. The nature of turbulent flow, flow near a boundary, the mixing length hypothesis; velocity profile near a boundary (smooth surface, rough surface); power-law profile; statistical theories of turbulence; eddy transport or momentum, heat and water vapour with planetary atmosphere boundary layer; the heat flux equation and the problem of convection; Richardson criteria; forced free convection.

LEARNING OUTCOME ON DYNAMIC METEOROLOGY

- To understand the processes leading to cloud formation and triggering processes/ propagation and regeneration
- To be able to describe processes and principles of NWP as well as interpreting NWP products

AGROMETEOROLOGY- BIP 334 (4UNITS)

1. Introduction, Definition, aims, Scope, Objective and relationship between Agricultural meteorology and other allied discipline.
2. The relationship between weather and agriculture, soil, plants, farm animals (Livestock); diseases and pest of crops and animals, farm building and equipment. Artificial modification of meteorological and hydrological regimes.

3. The history of Agriculture and its relationship with association science. Agricultural Ecology and Ecosystem Distribution and Classification of Vegetation belts in Nigeria. Weather and climatic modification
4. General production practice of field crops, crop production e.g. Maize Production factors for optimum yield of field crops. Factors affecting crop yield; Environmental factors – rainfall, CO_2, temperature, radiation, wind, light, evaporation water supply, nutrient, weed, pest and disease soil physical condition. Plant population, field of individual plant and community.
5. Plant protection definition of pest, important of pest. Important of plant protection. Types of Pests: Polyphagous pest, Locusts, Termites, Bihar hairy Caterpillar, Cutworm, Greasy Cutworm, Damage caused by locust phase. Theory of locust, life cycle of locusts and control.
6. Phenology Definition of phenology Method of phonological observations. Different phases of phonological

Observation in different crop plants.

7. Agrometeorological elements and their methods of observations.

Definition, climatic elements, Biological elements, conditions of observation, Agrometeorological station and Networks, Observation of physical elements, Observation of biological Character/Elements, Detail observation of high accuracy.

8. Climatic normal for livestock's: poultry birds, Goat, Sheep, Pigs and Cattle. Meteorological equipment of crop plants for rice, sugar cane, cotton, maize, potatoes etc. Animal's production systems, uses of animals. Outdoor animals and Meteorological elements.

9. Water and the Hydrological Cycle in Agriculture moisture characteristics of soil water and vegetation. Determination of water loss from land surface fundamental of the evaporation process.

Existing methods of determining evaporation Energy balance of estimating evaporation. Aerodynamic estimation of evaporation

combination model methods of penman and others. Development of original penman equation.

Evaporation formulae of priestle – Taylor and Penman – Monteith special forms of precipitation Dew, Snow, soil moisture Budgets – Irrigation needs

LEARNING OUTCOME FOR AGROMETEOROLOGY

- To understand the effect of meteorological and climatic data to crops and livestock
- To employ meteorological information to improve agricultural products

HYDROMETEOROLOGY- BIP 335 (3UNITS)

Hydrology, Hydrometeorology; Definitions and Explanations

Water bodies of the world, Role of water in Economic Activities of Nations:

Physical: properties of water cycle on the globe: physical properties of Water; the hydrological cycle on the earth; ground water; origin and Classification of ground water; physical properties of rocks in relationship to water; physical states and movement of ground water; ground water and its relationship to rivers; confined aquifer ground water and its role in the river feeding; Lakes and reservoirs; morphology of lakes; sources of inflow to lakes; water balance of lakes; dynamic phenomena on lakes (Waves and currents).

Heat regime of lakes; chemical composition of lake water; biological processes in Lakes; reservoirs, their regime and water balance; swamps; formation and classification of swamps; hydrological regime of swamps; formation and movement of glaciers, their influence on river inflow and regime.

River system; river basins; river valleys and channels; sources of river Flow; temperature regime of rivers; regime of river stages; movement of water in rivers; flow velocity; discharge in rivers, hydrograph analysis; sediment transport; chemical composition of river water; channel formation processes; water balance and runoff; units used to measure runoff and flow; water balance and runoff units used to measure run off and flow; water balance of bodies of water.

Calculation of evaporation from the surface of basin; Average long-term annual runoff: distribution of annual runoff in Months and seasons; flow duration curves, mass diagrams and Storage Behavior diagrams; maximum discharge and its calculation;

Minimum flow and its calculation; sediment discharge and its calculation.

General alter Balance equation

Hydrograph Analysis Knowledge of flood regime of a stream, intelligent design of a wide. Variety of hydraulic structures such as bridges and culvert openings. Reservoir spillways and flood control works of all sorts.

LEARNING OUTCOME ON HYDROMETEOROLOGY

To understand the components of the water cycle and its applications

ORAL ASSESSMENT- BIP 336 (3UNITS)

This is an organized session wherein the students are cross-examined to understanding what practically is ahead of them based on what exists in the field and how much had been imparted in them through various courses they have undertaken.

PROJECT- BIP 337 (4UNITS)

Students will be opportune to choose a title for his/her project work with relevance to Meteorology and be supervised by a RTC instructor. An oral presentation defense of the project will be done and will be graded alongside with the class work.

On completion of the project, students are to submit four bounded finished copies to their Class Advisers, who will in turn ensure proper distribution. The colour of the bound copies is deep blue black.

LEARNING OUTCOME ON PROJECT

To develop the skills of analyzing specific weather phenomenon/ variables and produce a project report

FUNDAMENTAL METEOROLOGY COURSE CURRICULUM AT RTC

TABLES OF CURRICULUM FOR FUNDAMENTAL METEOROLOGY COURSE

FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS
1	BIP 411	UPPER AIR OBSERVATIONS	3

2	BIP 412	CODES & OBSERVATION	4
3	BIP 413	METEOROLOGICAL INSTRUMENTS	3
4	BIP 414	PLOTTING	3
5	BIP 415	RESEARCH METHODOLOGY	3
6	BIP 416	CLIMATOLOGY	3
7	BIP 417	METEOROLOGICAL STATISTICS	3

SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS
1	BIP 421	CLIMAT RETURNS	3
2	BIP 422	APPLICATION OF REMOTE SENSING IN METEOROLOGICAL STUDIES	2
3	BIP 423	SYNOPTIC METEOROLOGY	3
4	BIP 424	SYNOPTIC WEATHER ANALYSIS	3
5	BIP 425	AERONAUTICAL METEOROLOGY I	3
6	BIP 426	HYDROMETEOROLOGY	3
7	BIP 427	CLIMATE CHANGE – IMPACTS, VULNERABILITY AND ADAPTATION	3
8	BIP 428	OJT	4

THIRD SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS
1	BIP 431	MARINE METEOROLOGY	3
2	BIP 432	AERONAUTICAL METEOROLOGY II	3
3	BIP 433	ATMOSPHERIC	3

		THERMODYNAMICS	
4	BIP 434	DYNAMIC METEOROLOGY	3
5	BIP 435	SATELLITE METEOROLOGY	3
6	BIP 436	PROJECT	6

LEARNING OUTCOME FOR UPPER AIR OBSERVATION

The students should be able to carry out sounding and the use of the instruments.

UPPER AIR OBSERVATION: (BIP 411)

1. General – Units of measurements. Meteorological balloons: There are three types of balloon colours in use for the measurement of upper wind:- Red, blue and white colour. The state of the sky determines the colour of balloon to be used. Gases for inflation of Meteorological balloon helium, or hydrogen gas. Hydrogen generator for Meteorological purposes. Theory of upper-wind measurement. Care and handling of Meteorological balloons. Sizes of Meteorological balloons. The Pilot – Balloon Theodolite. Ceiling measurement using pilot balloon (determination of cloud base). Optical Theodolite using pilot balloon
2. Pilot Balloon Codes PART A, B, C, D,
3. Temperature Message Identifier TTAA Radiosonde Transmitter

The weather elements observed are: Pressure, Temperature, Wind direction and speed, humidity and dew point.

5. Radio sounding of the upper atmosphere. General – units of measurement. The Principle of the radio sounding system: Principle of the radio sounding and ascent evaluation.

LEARNING OUTCOME ON CODES & OBSERVATION

- To be able to identify and understand the principle behind the formation and associated weather events
- Ability to collate climatic data for research purposes
- To be able to identify hydrometeors and their method of observation
- To be able to code and transmit information
- Ability to collate climatic data for research purposes
- To be able to conduct necessary observations and understand the techniques
- To be able to identify clouds and their associated characteristics and formation

. CODES AND OBSERVATIONS: (BIP 412)

17. Brief introduction to instrument used in taking meteorological observations.

18. Measurement of meteorological variables and procedure of observation, Specific features of Meteorological measurements; Direct and Indirect. Measurement of Temperatures; Air, Maximum, Minimum etc. Measurement of Humidity; Relative Humidity autographic instruments, derived values with the aid of Humidity slide rule, Measurement of Atmospheric Pressures (Barometers,) Barographs).
19. Measurement of Clouds; Types, Amount and Height (Ceilometers, ceiling Ascent, Cloud, Atlas and Pictures)
20. Measurement of surface Winds. Direction and speed; (Anemometers, and Beaufort scale for estimation).
21. Precipitation Measurements (Rates and Records of precipitation) Solid or Liquid, Gauges units. Precipitation (Amount and Duration). Automated weather station for intensity.
22. Measurement of Evaporation – Piche Evaporimeters
23. Visibility; General unit measurements, Definition of visibility (hydrometeor and lithometoes) and Visibility at night. Prevailing visibility/ directional visibility
24. Measurement of solar radiation (Sunshine recorders, Gunn Bellani radiation integrator and solarimeter).
25. Methods and procedures of observations Standard time, accuracy and measurement (UTC unit) Standard International Block and stations numbers e.g. Nigerian Stations.
26. Codes: Applications of SYNOP code for observation Section O -5
27. Present weather, Visibility and (Direction and speed), Application of METAR and SPECI Codes.
28. introduction to "9" special phenomenon groups i.e. 9spspspsp of synoptic message
29. Introduction to supplementary information groups of synoptic message e.g 5j1j2j3j4, 4ffff, 55408, 4esss etc.
30. section 5 555 of synoptic message e.g. 1sntxtxtx 2sntntntn 30uuu 40rrr
31. METAR modifications and corrections

SPECI modifications and corrections

LEARNING OUTCOMES OF METEOROLOGICAL INSTRUMENTS

- The students should be able to know the factors of siting the instruments and spacing of instruments

- They should be able to understand the underlying principle of the instruments in relation to units and dimensions and their mode of operation

- They should be able to conduct necessary observations and understand the techniques

METEOROLOGICAL INSTRUMENTS & MAINTENANCE: (BIP 413)

1. Direct and Indirect Meteorological measurement
   Measurement of meteorological variables

Specific features of Meteorological Measurement
Direct Reading Instruments: Thermometers, Barometer, Wind Vane, Cup-Counter Anemometer, Class A Pan, Gunn Bellani Radiation Integrator, Raingauge, Sunshine Recorder and Ordinary Anemometer.
Autographic Instrument (Indirect Reading Instruments): Thermograph, Barograph, Hyetograph and Hygrograph. Desirable Characteristics of Meteorological Instruments (Accuracy, durability and reliability).
General requirements for sitting and exposure of Meteorological Instruments.

2. Measurement of atmospheric pressure
Nature of atmospheric pressure – Units of measurements; Principles underlying the operation of atmospheric pressure measuring
Instruments; Mercury barometers; Kew Pattern Barometer and Fortins Barometer; Aneroid barometers; analogue and digital; The Principle of the barograph; Exposure of atmospheric pressure measuring instruments.

3 Measurement of air temperature; Nature and units of measurement of air temperature, temperature scales used in Meteorology and conversion. Principles underlying the operation of air – temperature measuring; Instruments; Mercury-in-glass thermometers, spirit-In-glass thermometers; The bimetallic thermometers, station thermograph ; Exposure of air temperature measuring instruments (source of errors); Re-Setting of thermometers.

4 Measurement of atmospheric humidity; Nature and units of measurement of absolute humidity, relative humidity and dew point and other humidity parameters; General principles of hygrometers.
Humidity measuring instruments based on change of dimension of Hygroscopic substances - the hair hygrometer, the psychrometer.
Automated psychrometer and recording Psychrometer.

5 Measurement of surface wind direction and speed; Wind direction and wind speed – specific feature units of measurement; Principles of wind measuring instruments; The pressure plate anemometer; Cup counter Anemometer- The rotation sensor cup – wheel – propeller; and Anemometers measuring run of wind.

6 Measurement of precipitation; General liquid and solid precipitation – units of measurement; Principles of the Point measurement of precipitation. Non – recording precipitation gauges – daily rain gauges of the unshielded and shaded types. Recording precipitation gauges – siphon (float type – tipping bucket and Weighing – balance type
Exposure requirements concerning precipitation point – measurement instruments. Routine care of precipitation measuring instruments; Factors affecting the accuracy of point – precipitation measurements (Evaporation Loss). Measurement of evaporation

7. General units of measurements, Principles of evaporation measuring
Instruments, the evaporation pan: Class A Pan – (the hook gauge type). General requirements for the evaporation – measuring instruments' exposure, routine care of evaporation – measuring instrument.

8 Sunshine duration measurement
General principles of sunshine duration measurement

The Campbell Stokes sunshine duration recorders. Sitting and exposure requirements for sunshine duration measuring
Instruments, factors affecting the sunshine records (Cloud cover, Precipitation). Routine care of the Campbell Stokes sunshine recorder.

9 Automation of the measurement of Meteorological variables.

Technical and economic aspects of automation objectives. Classification of automatic weather stations. Basic block diagram of an automatic weather station. Sensors used with automatic weather stations. Maintenance of automatic weather stations. Reliability of automatic equipment. Standard, quality control, calibration and inter comparison

LEARNING OUTCOMES ON PLOTTING

- To be able to identify and interpret ICAO codes and symbols
- To be able to plot all meteorological information on weather charts

PLOTTING (BIP 414)

5. Application of models and tables.
6. Locations of station on Charts
7. Data representation on charts. Data is represented on charts with international symbols.

Surface Plotting model, Ship message plotting model

LEARNING OUTCOME FOR RESEARCH METHODOLOGY

- Introduce students to what research is all about.
- Gain in depth knowledge in step by step way of doing research.
- Get exposed to different methods of data collection in research and methods of data analysis.
- Students will be able to know how to do to project

RESEARCH METHODOLOGY (BIP 415)

Course Outline:

- ✓ Meaning of research or concept of research
- ✓ Types of research
- ✓ Classification of research
- ✓ Characteristics of researcher
- ✓ Values of Research
- ✓ Ethical issues in research
- ✓ Research format: This is divided into:
  8. Projects preambles or preliminaries
  9. Introduction
  10. Conceptual or theoretical frame work and literature review
  11. Methodology
  12. Results and discussions

13. Summary, conclusion and recommendations
14. References

LEARNING OUTCOMES ON CLIMATOLOGY

- To be able to understand the elements involved in regional and local climates
- To be able to classify climates
- To be able to understand and appreciate the local climates to region of responsibility and their roles
- To be able to understand the importance of the global atmosphere and its spatio-temporal variability
- To appreciate the geographical characteristics of their area
- To be able to understand tropical disturbances and their roles in weather processes and the ITD
- To appreciate the physical processes of energy transfer from the sun to the earth surface and its application

CLIMATOLOGY (BIP 416)

4. Definition of weather and climate. Techniques usually adopted in climatology.
   Climatic controls of a place and West Africa.
   Climatic Elements.
   Climatological elements. All elements of weather should be discussed, but emphasis on those which actually shape the climate of a place e.g. temperature (including radiation), winds, pressure, sky cover, radiation, precipitation, humidity (including rainfall and air mass structure in the area).
5. The climate of Nigeria
   The ITD-Definition and its seasonal movement. Its role in determining the climate of various places in Nigeria on a meridional axis.
   The seasons in Nigeria
   The length of the rainy and dry seasons in Nigeria
   The two seasons in Nigeria; the prevailing winds and principal air masses associated with each season. Relationship between winds and air masses.
6. Weather zones in Nigeria
   Climatological characteristics of each zone. Basis for the existence of the weather zones. Meridional movement of the ITD.

4. Regional climatology: geographical distribution of climates, Climatolography. Monsoon climate with definite seasonal pattern (wet and dry tropics). Climatic Classification
   Tropical climate
   Tropical arid and semi arid climates
   Temperate climate

Polar climate
Tundra, taiga
topoclimate

5. Climatic statistics and Applications
6. Climate variability and Climate Change.

LEARNING OUTCOMES FOR METEOROLOGICAL STATISTICS

1. Understand principles of statistical analysis for meteorological data
2. Know the methods of obtaining data and how to avoid common design flaws that lead to bias and inefficiency
3. Know how to apply fundamental concepts in exploratory meteorological/climatic data analysis.
4. Understand how to apply and interpret basic summary and modelling techniques
5. Know the basic concepts of probability and random variables in relation to weather phenomena.
6. Understand the concept of the sampling theory, foundations for classical inference involving confidence intervals and hypothesis testing.
7 Understand basic concept of some software packages for meteorological/climatic data analysis

METEOROLOGICAL STATISTICS (BIP 417)

1.1 Explain the concept of Statistics Define the following:

iv. Data
v. Dispersion
vi. Errors etc

2.1 Explain the concept of data collection
2.2 Identify different methods of obtaining data1 Define the following:

x. Frequency distribution
xi. Array
xii. Range
xiii. Tally bar
xiv. Class frequency
xv. Number of classes
xvi. Class Interval
xvii. Class Boundary
xviii. Class Mark

3.2 Explain the concept of data representation
3 Calculate the following:

vii. Measures of central tendency (the
viii. mean, median and mode of grouped
ix. data; quartiles, deciles and
x. percentiles)
xi. Measures of dispersion (Range,
xii. Mean deviation and standard

Deviation, coefficient of variation)
1 Explain the concept of scatter graph, regression and correlation analysis

4.2 Undertake scatter graph, regression and correlation analysis
Define and explain the concept of probability and its calculations
5.2 Explain the following:

ix. Events
x. Various types of events
xi. Trials and random variables,
xii. mathematical expectation
xiii. Permutations and combination.
xiv. Probability distributions;
xv. (Binomial, Poisson and Normal
xvi. distributions)

Compute above using meteorological data
5.2 Calculate the following:

iv. Standard errors (Mean and standard deviation)
v. Recurrence estimates
vi. Return period of extreme events

5.3Derive probabilities from various forms of events
Explain the following:

viii. Meaning of sampling theory
ix. Various sampling techniques.
x. Sampling error.
xi. Sampling distribution of means.
xii. Characteristics of Student's t-
xiii. distribution.
xiv. Degree of freedom

6. Calculate the following:

iii. Confidence intervals for sample means and sample proportions using Student's t-distribution.
iv. Chi-Square

7. Explain the following:

v. Tests of significance
vi. Null hypothesis
vii. Alternate hypothesis
viii. Type I and Type II errors.

Confidence levels of accepting or rejecting hypotheses (Null and alternate hypotheses

Describe the use of some Microsoft Office, computer packages (Word, Excel, Power point)
7. Analyze data using Microsoft Excel

LEARNING OUTCOMES ON CLIMAT RETURNS

- Ability to collate and archive climatic data for research purposes

CLIMAT RETURNS (BIP 421)

. CLIMATOLOGICAL RETURNS

1. Climatological returns; its meaning; importance; qualities; Types of forms; Form Met.100; Form Met. 101, Form Met. 102; Form Met. 103, Form Met. 104; Form Met. 113; Form Met. 120; Form Met. 130; Form Met. 131; Form Met. 135; Form Met. 141l, Form Met. 143; Form Met. 145; Form Met. 146; Form Met. 147; Form Met. 509; Form Met. 4520; Form Met. 4521; Form Met.4522; Compilation; Computation;
2. Climatological returns forms and usage
   Autographic chart analysis and entries into appropriate form
   Extraction of meteorological data from climatological returns
   Checking of climatological returns.

Application of Remote Sensing and GIS in Meteorological studies (BIP 422)

GIS/REMOTE SENSING

1. The nature of Geographic information I
   - Maps and spatial information
   - Characterising geographic features
   - Spatial data accuracy and quality
2. The nature of Geographic information II
   - What is GIS?
   - Components of a GIS
   - GIS Data Model
   - Spatial data relationships
3. Data Sources
   - Sources of data
   - Data input techniques
   - Data editing and quality assurance
4. Data organisation and storage
   - Organising data for analysis
   - Editing and updating of data
5. Data analysis
   - Manipulation and transformation of spatial data
   - Integration and modelling of spatial data
   - Integrated analytical function
6. Implementation issues and strategies
   - Current options and software assessment
   - Justification and expectations
   - Implementation issues
7. Development and Trends
   - New data sources
   - Hardware development
   - Software development

LEARNING OUTCOMES FOR SYNOPTIC METEOROLOGY

- To Be Able To Identify Clouds And Their Associated Characteristics And Formation
- To Be Able To Understand The Importance Of The Global Atmosphere And Its Spatio-Temporal Variability
- To Be Able To Identify The Various Synoptic Features Meteorological Charts And Imageries And Their Effects
- To Be Able To Understand Tropical Disturbances And Their Roles In Weather Processes And The ITD
- To Be Able To Understand The Connection Between Tropical And Extra-Tropical Systems
- To Understand The Processes Leading To Cloud Formation And Triggering Processes/ Propagation And Regeneration

- To Be Able To Understand The Concept Of Mesoscale Systems In The Tropics
- To Be Able To Understand And Explain The Concept Of Airmasses And The Modification.
- To Be Able To Identify The Hazardous Weather Situations And Their Socio-Economic Importance To The Area Of Consideration

SYNOPTIC METEOROLOGY (BIP 423)

1. Introduction and Definition of Synoptic Meteorology.
2. ITD and the associated weather zones. Waves and jet streams, land and Sea breeze, anabatic and Katabatic winds. Evolution and Dynamics of west African line squall.
3. Tropical Weather systems. Trade inversions trade winds, Tropical/subtropical jet streams, and other broad wind systems. Rainfall, Tropical cyclones, monsoons. Characteristic patterns of cloud associated with easterly waves, seasonal evolution of the tropical wind systems, and the inter-tropical convergence zone; annual cycles.
4. Mid-latitude synoptic systems. Air-mass concept; source areas; formation processes for air-masses. Air-mass modification; thermodynamic and dynamic changes; boundary/interface between two adjacent air masses; the slope of steady-state frontal zones; frontal-wave depression.
5. General circulation

LEARNING OUTCOMES ON SYNOPTIC WEATHER ANALYSIS

- To be able to identify and understand the principle behind the formation and associated weather events
- To be able to understand the concept of weather developments at different scales over point location
- To be able to identify the various synoptic features, meteorological charts and imageries and their effects
- To be able to identify the various synoptic features meteorological charts and imageries and their effects

- To be able to evaluate the recent technology used for the display of weather systems, their benefits and shortcomings

SYNOPTIC WEATHER ANALYSIS (BIP 424)

1. Definition of various Isolines
2. Rules governing Analysis/Nature of Analysis
3. Types of Charts used in Analysis
4. Analysis of various elements (Surface and Upper Air)
5. -Temperature, Wind, Humidity, Dew point, Divergence, Vorticity etc
6. Introduction to Numerical weather Prediction
7. Tephigram: Analysis & Interpretation.

LEARNING OUTCOMES FOR AERONAUTICAL METEOROLOGY I

- Familiarize students to terminologies in aeronautical meteorology.
- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to understand the various aviation meteorological hazards and to know what to do to ameliorate the effect of such hazards on operation of aircrafts.
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

AERONAUTICAL METEOROLOGY I (BIP 425)

1. Definitions of Terms: Aeronautical Meteorology, Meteorological report, observation, visibility, runway visual range. Altitude, elevation height, aerodrome elevation, flight level, transition level, and aerodrome meteorological minima
2. Observing techniques. Surface wind direction and speed, including changes and variations. Visibility and runway visual range, including spatial and temporal variations in RVR observations, cloud amount, height and type and spatial and temporal variations. Vertical visibility, observations using automatic instruments such as ceilometers. Pressure measurements for the purpose of determining QFE and QNH.
3. Reporting, coding and dissemination of weather information. Complete knowledge of international meteorological codes related to observations such as METAR and SPECI. Knowledge of procedure

for dissemination of weather information at the aerodrome, including the special needs of ATC units. Knowledge of the procedures for the preparation of the plain language forms of meteorological messages.

4. Hazardous phenomena: Aircraft icing. Elementary knowledge of icing types; formation, accretion rates and association of icing with clouds; turbulence, elementary knowledge of turbulence near the ground as related to topography; elementary knowledge of high level turbulence (CAT) and its association with jet streams. Wind shear and volcanic ash.
5. Introduction to the responsibilities of ICAO and WMO in aeronautical meteorology.
6. Aeronautical telecommunications. Elementary understanding of the general organization of aeronautical telecommunications, but they should have a good working knowledge of the operation of the aeronautical fixed service.
7. WMO documents: Technical regulations, (WMO-No 49) Vol II – Meteorological service for International Air Navigation. Manual on codes (WMO-No 306). Guide to Meteorological Instruments and methods of observation (WMO-No 8). Weather reporting (WMO-No 9).

Learning outcome for Hydro Meteorology

- To understand the components of the water cycle and its applications.

Hydro Meteorology: (BIP 426)

1. Hydrology, Hydrometeorology; Definitions and Explanations. Water bodies of the world, Role of water in Economic Activities of nations.
2. Physical: properties of water cycle on the globe: physical properties of Water; the hydrological cycle on the earth; ground water; origin and Classification of ground water; physical properties of rocks in relationship to water; physical states and movement of ground water; ground water and its relationship to rivers; confined aquifer ground water and its role in the river feeding; Lakes and reservoirs; morphology of lakes; sources of inflow to lakes; water balance of lakes; dynamic phenomena on lakes (Waves and currents).

3. Heat regime of lakes; chemical composition of lake water; biological processes in Lakes; reservoirs, their regime and water balance; swamps; formation and classification of swamps; hydrological regime of swamps; formation and movement of glaciers, their influence on river inflow and regime.
4. River system; river basins; river valleys and channels; sources of river Flow; temperature regime of rivers; regime of river stages; movement of water in rivers; flow velocity; discharge in rivers, hydrograph analysis; sediment transport; chemical composition of river water; channel formation processes; water balance and runoff; units used to measure runoff and flow; water balance and runoff units used to measure run off and flow; water balance of bodies of water.
5. Calculation of evaporation from the surface of basin;
    a. Average long-term annual runoff: distribution of annual runoff in
    b. Months and seasons; flow duration curves, mass diagrams and
    c. Storage Behaviour diagrams; maximum discharge and its calculation;
    d. Minimum flow and its calculation; sediment discharge and its calculation.
6. General alter Balance equation
7. Hydrograph Analysis Knowledge of flood regime of a stream, intelligent design of a wide. Variety of hydraulic structures such as bridges and culvert openings. Reservoir spillways and flood control works of all sorts

LEARNING OUTCOMES ON INTRODUCTION TO CLIMATE CHANGE

To understand the concept of climate change studies

INTRODUCTION TO CLIMATE CHANGE (BIP 427)

1. Introduction**:** The concept of climate: Climate variation and Climate change.
2. The Climate System**:** How climate is generated, components of the climate system, i.e the atmosphere, the lithosphere, the oceans, the cryosphere and the biosphere.
3. History of climate change
4. Theories of possible causes of climate change**:** Terrestrial theories; Astronomical theories; Extra-terrestrial theories; the Global warming debate.
5. Potential impacts of global warming and climate change: Impacts on agriculture and land use; impacts on the ecosystems and biodiversity; impacts on human settlements; impacts on human settlements; impacts on diseases and health and impacts on hydrology an d water resources.
6. Vulnerability to climate change: The concept of vulnerability; assessing vulnerability to climate change and reducing vulnerability to climate change.
7. Response strategies to climate change: Climate change mitigation strategies; climate change adaptation strategies; climate change and

coastal zone management; climate change – water management and agriculture.

8. The Climate prediction**:** Weather prediction and climate prediction methods and problems of climate prediction. Future weather and climate- the way forward.

LEARNING OUTCOMES FOR METEOROLOGICAL STATISTICS

1. Understand principles of statistical analysis for meteorological data
2. Know the methods of obtaining data and how to avoid common design flaws that lead to bias and inefficiency
3. Know how to apply fundamental concepts in exploratory meteorological/climatic data analysis.
4. Understand how to apply and interpret basic summary and modelling techniques
5. Know the basic concepts of probability and random variables in relation to weather phenomena.
6. Understand the concept of the sampling theory, foundations for classical inference involving confidence intervals and hypothesis testing.
7 Understand basic concept of some software packages for meteorological/climatic data analysis

OJT- BIP 428

It is a skills training programme designed to give students first experience in a working environment to complement the theoretical learning. It equip the students with qualities of leadership and integrity.

The OJT will be carried out for three months.

9. The students will be divided into groups.
10. Each group will be sent to sections/units of the Agency within Lagos including Ikeja (Forecast office).
11. The students are to be supervised by the RTC instructors.
12. At the end of the OJT they are to submit their logbooks dully signed by the head of the section. And also present a written report.

LEARNING OUTCOME ON PROJECT

By the end of the training the students will be able to;

a. Apply their knowledge in real work situation thereby bridging the gaps between theory and practice.

b. Acquire interpersonal skills by meeting with professional in the field of study.

MARINE METEOROLOGY: (BIP 431)

1. Introduction
   - General Introduction of Marine Meteorology
   - Water coverage, Air-Sea interaction
   - Uses Marine Meteorological Information

2. Marine Meteorological Services [MMS].
   - Purpose and Principles of MMS
   - Data acquisition and Types of Data in Marine
   - Types of Sea Stations
3. Components of MMS- High seas, coastal/offshore, Port/harbor and training
4. Observation in Marine
   - Importance of Marine Observation
   - Marine Meteorological Variables: Definition, general description and importance of variables
   - Dissemination procedure of Marine Meteorological Information
5. The Ocean and current measurement
   - Oceans and its Dimensions
   - Hydrostatic Pressure, illumination and temperature of the ocean
   - Salinity and its measurement
   - Ocean current I; definition and measurement
6. Ocean Temperature
   - Sea surface temperature; Definition and uses
   - Methods of measurements
   - Diurnal/horizontal variability
   - Influences on Weather
   - Sub-surface temperature; Definition and measurement
   - Effects of temperature on marine life
7. Marine Meteorological codes and ship messages
   - Need for Codes and Marine logbook
   - Categories of ship messages
   - Coding and decoding of ship messages
8. Ocean Waves
   - Wave characteristics
   - Wave formation and growth
   - Relationship among Waves in deep and shallow waters
   - Wave measurements

LEARNING OUTCOMES FOR AERONAUTIC METEOROLOGY II

- Familiarize students to terminologies in aeronautical meteorology.
- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to issue aviation reports for safety of aircrafts
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

AERONAUTICAL METEOROLOGY II (BIP 432)

Terminal Aerodrome Forecasts (TAFs)

Aerodrome warnings

Windshear warnings

Significant Meteorological Information (SIGMET

Weather Briefing and flight documentations

Area Forecasts

LEARNING OUTCOMES ON ATMOSPHERIC THERMODYNAMICS

- Understanding of the physical laws and its application to atmospheric science
- To be able to identify the various synoptic features meteorological charts and imageries and their effects
- To understand movement of air constituents

ATMOSPHERIC THERMODYNAMICS (BIP 433)

1. Introduction to thermodynamics System
2. Gas laws - Boyle's and Charles' Laws, Dalton's Law of partial pressures, Ideal gas law. Equation of state for dry and moist air, Mixture of gases. Kinetic theory of gases.
3. Adiabatic processes. Definitions, Dry, Moist and Pseudo – adiabatic processes. Equations for adiabatic processes, Dry, moist and saturated adiabatic lapse rates. Poisson equation and potential temperature. Latent heat of condensation. Comparison of magnitudes of different lapse rates. Methods of determining stability – parcel and slice methods. Hydrostatic balance, Potential energy, Geopotential meter and geopotential height.
4. Conservation of energy and the first law of thermodynamics. Change of phase and latent heat. Reversible and irreversible processes.
5. Hydrostatic stability and Convection.
6. Moisture variables. Definitions and meanings of Potential temperature, vapour pressure, mixing ratio, absolute humidity, equivalent potential temperature, saturation mixing ratio, absolute humidity, dew point temperature, specific humidity, virtual temperature etc.
7. Thermodynamic cycle. Carnot cycle, Isothermal and adiabatic expansion and compression.

LEARNING OUTCOME ON DYNAMIC METEOROLOGY

- To be able to identify the hazardous weather situations and their socio-economic importance to the area of consideration
- To be able to understand the concept of mesoscale systems in the tropics
- To understand the concept of air flow and its role of wind and its effect to weather development
- To be able to understand and explain the concept of airmasses and the modification.

- To be able to understand the connection between tropical and extra-tropical systems

DYNAMIC METEOROLOGY (BIP 414)

1. Concept of dynamic meteorology compared with synoptic and Physical Meteorology, physical dimensions and units.
2. Atmospheric scales; pressure gradient, gravitational, centrifugal, gravity and coriolis forces, equation of motion in a simple form, geostrophic wind, wind and pressure near the equator; gradient wind and comparison with geostrophic wind, trajectories and streamlines, cyclostrophic wind; flow within the planetary boundary layer (cross-isobaric flow)
3. Ageostrophic and Isallobaric winds. Hydrostatic equilibrium and Hypsometric equation and uses. Thermal wind, divergence, convergence and vertical motion. Intensification and deepening of pressure systems. Vorticity (relative and absolute). Formation of cyclones and anti cyclones. Turbulence and gustiness, eddies and vertical transport of matter, clear-air turbulence.

LEARNING OUTCOMES ON SATELLITE METEOROLOGY

- To be able to identify hydrometeors and their method of observation
- To be able to conduct necessary observations and understand the techniques
- To be able to identify the various synoptic features of meteorological charts and imageries and their effects
- To be able to identify clouds and their associated characteristics and formation

SATELLITE METEOROLOGY (BIP 435)

1. Basics in remote sensing Physics behind remote-sensing
2. Introduction to History of meteorology satellites
3. Satellites-data acquisition, processing and archiving
4. Satellite orbits, characteristics and radiometers
5. Satellite data acquisition, processing and data management.
6. Satellite image analysis, display and interpretation
7. Application of satellite imagery both in the visible and infrared
8. Regions for the analysis and interpretation of weather systems.
9. Case-studies, that is, a series of practical examples to examine a range of Meteorological events over the African continent, tropics and mid-latitude with emphasis on the application of satellite Meteorology to public weather forecast, Aeronautical Meteorology and Agro-meteorology.
10. Future of satellites meteorology

FIELDWORK: (BIP 436)

This is a week study of meteorological, hydrological and geographical phenomena that influence weather and climate. Impact of weather and climate on Agriculture, Water Resources, coastal areas, tourism and desertification are studied. While NIMET takes care of transportation and accommodation of Staff and Students, the Students will take care of their feeding. This study will take place in any part of the Country or West African Sub-region

PROJECT (BIP 437)

Students may choose a title of his/her project work with relevance to Meteorology/related field and to be supervised by RTC instructor. There is going to be an oral presentation defence of the project and to be graded alongside with the class work. Once the project is completed, students are to submit three bound finished copies to the office of program Director. The colour of the project cover is green.

5.8 CURRICULUM FOR SPECIALIZED PROGRAMMES

5.8.1 CERTIFICATE COURSE IN CLIMATOLOGY

The Tailored Certificate Course in Climatology will be satisfied through successful completion of the following curriculum for Applied Climatology:

S/N	COURSE CODE	COURSE NAME	LECTURER	UNIT(S)
1	**CLI 101**	**Climatology**	Mrs Williams	3
2	**CLI 102**	**Computer Studies**	Mrs Maguagwu	2
3	**CLI 103**	**Climate Change**	Mr Aremu	3
4	**CLI 104**	**General Meteorology**	Mr Ojo	3
5	**CLI 105**	**Physical Meteorology**	Mrs Oluwatosin	3
6	**CLI 106**	**Statistics**	Mrs Iheme	4
7	**CLI 107**	**Synoptic Meteorology**	Mrs Asaniyan	4
8	**CLI 108**	**Data Processing I**	Mr Kolade	4
9	**CLI 109**	**Dynamic Meteorology**	Mr Ige	3
10	**CLI 110**	**Meteorological Instruments**	Mr Isioro	4

LEARNING OUTCOME FOR CLIMATOLOGY

- To have the understanding of the physical climate system and climate change impacts

COURSE OUTLINES FOR CERTIFICATE COURSE IN CLIMATOLOGY

A. CLIMATOLOGY - CLI 101

1. Introduction, Clear distinction between weather and climate
2. Climatological elements, All elements of weather should be discussed, but emphasis on those which actually shape the climate of a pl ace e.g. temperature (including radiation), winds, humidity,precipitation (including rainfall and air mass structure in the area)
3. Factors which can affects or modify the Climate of a place
4. Climatological Maps
5. The climatic regions of the world. The role of air masses in determining the major climatic regions of the world
6. Diurnal Variations of Temperature, Pressure, Wind Speed, etc
7. Introduction to General Circulation (Types of motions; Pressure and Wind patterns)
8. Air Masses, The two seasons in Nigeria, The prevailing winds and principal air masses
9. The climate of Nigeria, The ITD and its seasonal movements, Its role in determining the climate of various places in Nigeria
10. Weather zones in Nigeria, Climatological characteristics of each zone, Basis for the existence of the Weather zones
11. The length of the rainy and dry seasons with Nigeria as illustration, Approximate on-set dates (months) for the two major seasons in Nigeria (Rainy and dry seasons), Reasons for the variation of the on-set dates in Nigeria
12. Monsoon climate with definite seasonal pattern (wet and dry tropics), tropical climate, tropical arid and semi-arid climates, temperate climate, polar climate,
13. Climatic scales, macro-, meso-, micro-climates
14. Climatic Classification; Climatic Regions of the World; Tropical and Equatorial, Tropical and Mid – latitude, Polar and Artic, Mountain Climates, Local Climates, Desert Climates, Acclimatization
15. Applied Climatology; Climate and Transport, Climate and Construction Climate and Water Resources, Climate and Agriculture, Climate and Business, Climate and Sports
16. Processing of climatological data – application of statistical method
17. African climate, Climatology of basic meteorological systems for the African continent especially on a North – South axis in West and Central Africa
18. The monsoons of the world with specific reference to West Africa, East Africa and India.
19. Anthropogenic impact on the climate system in Nigeria

B. COMPUTER STUDIES - CLI 102

1. Evolution of the computer systems: Definitions of computer; History of the computer (The beginning of computer age); Generations of computers; Types of computers; Classifications of digital computers; Characteristics of computers; Application of computers in the society.
2. Functional parts of a digital computer: Hardware (Input units, Output units, Processing units, Storage units, Communication units) and software (types of computer software, operating system, application software).
3. Computer Safety and Maintenance (Top Computer Mistakes Beginners Make, Basic Troubleshooting Techniques, Maintaining Your Computer).
4. Using the computer (Buttons and parts on a computer, Setting up a computer, Computer safety and maintenance).
5. Introduction To Data Transmission And Computer Networking (Data Transmission, Data Transmission And Communication Facilities, Computer Network, Types Of Network, Network Configurations, The Internet And The Electronic Mail).
6. Introduction To Computer Programming (Flowchart And Algorithm, Introduction To The BASIC Programming Language)

C. CLIMATE CHANGE - CLI 103

11. Introduction**:** The concept of climate: Climate variation and Climate change.

12. The Climate System**:** How climate is generated, components of the climate system, i.e the atmosphere, the lithosphere, the oceans, the cryosphere and the biosphere.
13. History of climate change
14. Theories of possible causes of climate change**:** Terrestrial theories; Astronomical theories; Extra-terrestrial theories; the Global warming debate.

15. Potential impacts of global warming and climate change: Impacts on agriculture and land use; impacts on the ecosystems and biodiversity; impacts on human settlements; impacts on human settlements; impacts on diseases and health and impacts on hydrology an d water resources.

16. Vulnerability to climate change: The concept of vulnerability; assessing vulnerability to climate change and reducing vulnerability to climate change.
17. Response strategies to climate change: Climate change mitigation strategies; climate change adaptation strategies; climate change and coastal zone management; climate change – water management and agriculture.
18. The Climate prediction**:** Weather prediction and climate prediction methods and problems of climate prediction. Future weather and climate- the way forward.

D. GENERAL METEOROLOGY - CLI 104

1. The layers and composition of the atmosphere: water vapour; carbon dioxide; etc. Vertical divisions of the atmosphere – troposphere; stratosphere; mesosphere; thermosphere; ionosphere.

2. Heat exchange processes in the atmosphere; solar and terrestrial radiation; Conduction and convection; advection; energy budget of the atmosphere; effect of radiation at the earth's surface; temperature difference between land and sea surfaces.
3. Elementary knowledge of synoptic and dynamic meteorology; air motion; Significance of scale; the winds and their causes; rudiments of the General circulation in the tropics and in non-tropical regions; local Winds; diurnal wind variation (breezes) and annual wind variations (monsoons); relation between the horizontal pressure gradient and the Winds; Buys-Ballot's law and the geostrophic wind; cyclones and Anticyclones; air masses and fronts; thunderstorms; synoptic chart analyses; Weather associated with synoptic systems.
4. Atmospheric temperature; horizontal and vertical variations of air Temperature, troposphere and stratosphere.
5. The effect of gravity on the atmosphere, air density, Atmospheric pressure, Variations in pressure; mean sea level pressure; horizontal and vertical pressures; significance of pressure gradient.
6. The three states of water; vapour pressure; saturation vapour pressure; evaporation, condensation; freezing; sublimation; isobaric and adiabatic processes; latent heat; Moisture indicators; relative humidity; mixing ratio and dew point.
7. Rudiments of cloud, fog and precipitation formation; visibility, the influence of water vapour, of water drops and dust (aerosols).
8. Basic knowledge of the vertical stability or instability; non-saturated air and saturated air; isobaric expansion and adiabatic expansion; the influence of condensation

E. PHYSICAL METEOROLOGY - CLI 105

1. Introduction to physical meteorology.
2. Transparency of the atmosphere and visibility.
3. Definitions, basic knowledge and formation of Clouds (International cloud classification, stratiform clouds, cumuliform clouds, orographic clouds), Fog (Fog Classification) and Precipitation (Process of raindrop formation, artificial rain).
4. Large- and small-scale cooling of the air due to adiabatic and non-adiabatic processes.
5. Elements of Atmospheric Optics and Electricity; Atmospheric ions and the Conductivity of the air; Refraction; Rainbow; Halo; Corona; Blueness of the sky; Lightning discharge and thunderstorms.

F. STATISTICS - CLI 106

1. Introduction: Definitions, meaning of statistics, examples with natural situations, Data collection and storage.
2. Data arrangement: Mean, median, mode, Mean of grouped and ungrouped data, Assumed Mean, Arithmetic and Geometric mean. Median and mode for grouped Data
3. Graphical representation of data: Graphs, Pie chart, bar chart, Frequency table, cumulative frequency.
4. Applications: Daily and monthly means of weather elements like temperature, pressure, Humidity, etc.

5. Regression and Correlation, Scatter graphs, Relationships between two variables and scatter graphs (construction of line of best fit, estimate from scatter graphs, significance of the scatter graph, limitations of scatter graph); computing regression lines (equation of straight line, measuring the Deviations; graphing Regression lines; the use of regression lines; choice of regression line and Regression coefficient; Multiple linear regression and non–linear regression); Correlation (computation of r; interpretation of r; types of correlation; Spurious correlation; Rank correlation).

G. SYNOPTIC METEOROLOGY - CLI 107

1. Tropical Weather systems; Tropical/subtropical jet streams, and other broad wind systems (AEJ, Trade winds, seasonal evolution of the tropical wind systems, and ITD / ITCZ; annual cycles); Tropical cyclones; Monsoons; Synoptic analysis of the disturbance patterns at the surface and their relation to high-altitude features.
2. ITD / ITCZ and the associated weather zones.
3. Waves and jet streams. Sea breeze, Anabatic and Katabatic winds.
4. Mid-latitude synoptic systems. Air-masses – source regions; formation processes of air-masses; Air-mass modification; frontal-wave depression.
5. Global observing system (Synoptic data for Surface, Upper-air and Special observations; coding and decoding, representation and analysis of meteorological data; quality control); World Weather Watch Program; Global Meteorological Telecommunications Network.
6. General circulation and the pressure systems.
7. West –African line squall.
8. Harmattan dust haze
9. Monsoons
10. Little dry season
11. African waves
12. Forcing functions.
13. Frontal systems
14. West African Jets.

H. DATA PROCESSING I - CLI 108

1. Introduction to Data Processing; Definitions, Types, Categories and Method of Data Processing, Basic Data processing, etc.
2. The Concept of Data and Information; Data processing system and Information System and their classification, Development of Information Management.
3. Data processing cycle; Areas and Stages of Data processing, Data Input, Storage , Output and Processing Techniques.
4. Data processing operations; Data Collection, Data Review, Data Entry, Data validation and types, Data processing Jobs and activities, Data types and Structures, Centralized and Decentralized Data processing Centres etc.

I. DYNAMIC METEOROLOGY - CLI 109

1. Concept of dynamic meteorology compared with synoptic and physical meteorology, physical dimensions and units.
2. Atmospheric scales, discussions on pressure gradient, gravitational, frictional, centrifugal, Gravity and carioles forces, total local derivatives, transformation from non-rotating co-ordinate system; equation of motion in vector form as derived from Newton's second law, Equation of motion in spherical co-ordinates (tangent plane approximation); scale analysis leading to simplified equations.
3. Ageostrophic and isallobaric winds, hydrostatic equilibrium and Hypsometric equation and uses, thermal wind, divergence, convergence and vertical motion, intensification and deepening of pressure systems, vorticity(relative and absolute), formation of cyclones and anti cyclones; turbulence and gustiness, eddies and vertical transport of matter, clear-air turbulence.
4. Horizontal balanced motions, motion with no tangential acceleration, geostrophic and gradient wind relations, comparism of geostrophic and gradient wind, geostrophic thermal wind, streamlines and trajectories, barotrophic and baroclinic atmosphere, thermodynamic energy equation, continuity equation, divergence of three dimensional and horizontal wind fields, vertical motion, vortices and circulation, Bjeknes' circulation theorem, introduction to stream friction and velocity potential, Rossby long waves, brief description of the baroclinic waves and baroclinic instability.
5. Introduction to hydrostatic approximation, justification for this approximation, equation of quasi-hydrostatic motion using pressure as vertical co-ordinate.
6. The nature of turbulent flow, flow near a boundary, the mixing length hypothesis; velocity profile near a boundary (smooth surface, rough surface); ower-law profile; statistical theories of turbulence; eddy transport or momentum, heat and water vapour with planetary atmosphere boundary layer; the heat flux equation and the problem of convection; Richardson criteria; forced and free convection.

J. METEOROLOGICAL INSTRUMENTS - CLI 110

1. Measurement of meteorological variables, Specific features of Meteorological Measurement, Direct and indirect Meteorological measurement, Direct Reading Instruments, Indirect Reading Instruments, Desirable Characteristics of Meteorological Instruments, General requirements for sitting and exposure of Meteorological Instruments.
2. Measurement of atmospheric pressure, Units of measurements of atmospheric pressure, Principles underlying the operation of atmospheric pressure measuring Instruments (Mercury barometers, Kew Pattern Barometer and Fortin Barometer, Aneroid barometers, barographs), Exposure of atmospheric pressure measuring instruments.
3. Measurement of air temperature, units of measurement of air temperature, temperature scales used in Meteorology and conversion, Principles underlying the operation of air – temperature measuring Instruments (Mercury-in-glass thermometers, spirit-In-glass thermometers, The bimetallic thermometers, thermographs), Exposure of air temperature measuring instruments – radiation errors, Setting time of thermometers.

4. Measurement of atmospheric humidity, units of measurement of absolute humidity, relative humidity, dew point and other humidity parameters. General principles of hygrometers. Humidity measuring instruments based on change of dimension of Hygroscopic substances (the hair hygrometer, the psychrometer).
5. Measurement of surface wind direction and speed, units of measurements of wind direction and wind speed, Principles of wind measuring instruments (The pressure plate anemometer, The rotation sensor cup – wheel – propeller, Anemometers measuring run of wind).
6. Measurement of precipitation (liquid and solid precipitation), units of measurement, Principles of the Point measurement of precipitation, Non – recording precipitation gauges (daily rain gauges of the unshielded and shielded types), Recording precipitation gauges (siphon, float type, tipping bucket, Weighing balance type), Exposure requirements concerning precipitation point – measurement instruments, Routine care of precipitation measuring instruments, Factors affecting the accuracy of point – precipitation measurements.
7. Measurement of evaporation, General units of measurements, Principles of evaporation measuring Instruments (evaporation pan: Class A Pan, the hooked – gauge type, etc.), General requirements for the evaporation measuring instruments' Exposure, routine care of evaporation – measuring instruments.
8. Sunshine duration measurement, General principles of sunshine duration measurement, The Campbell Stokes sunshine duration recorders, Sitting and exposure requirements for sunshine duration measuring instruments; factors affecting the sunshine records of the Campbell Stokes instrument, Routine care of the Campbell Stokes sunshine recorder, measurement of burnt trace on the cards.
9. Automation of the measurement of Meteorological variables, Technical and economic aspects of automation objectives, Classification of automatic weather stations, Basic block diagram of an automatic weather station, Sensors used with automatic weather stations, Maintenance of automatic weather stations, Reliability of automatic equipment.

5.8.3 CERTIFICATE COURSE IN DATA PROCESSING

The Tailored Certificate Course in Data Processing will be satisfied through successful completion of the following curriculum for Data Processing and Management:

S/N	COURSE CODE	COURSE NAME	UNIT(S)
1	**DAT 101**	**Computer Studies**	2
2	**DAT 102**	**Computer Operations**	3

3	**DAT 103**	**Data Processing I**	4
4	**DAT 104**	**Data Processing II**	3
5	**DAT 105**	**Computer Programming**	3
6	**DAT 106**	**General Meteorology**	3
7	**DAT 107**	**Met Statistics**	3
8	**DAT 108**	**Climatology**	3

LEARNING OUTCOME FOR DATA PROCESSING

- Improve trainee's technical and operational skills in data management practice, and its application at work

COURSE OUTLINES FOR CERTIFICATE COURSE IN DATA PROCESSING

COMPUTER STUDIES - DAT 101

1. Evolution of the computer systems: Definitions of computer; History of the computer (The beginning of computer age); Generations of computers; Types of computers; Classifications of digital computers; Characteristics of computers; Application of computers in the society.
2. Functional parts of a digital computer: Hardware (Input units, Output units, Processing units, Storage units, Communication units) and software (types of computer software, operating system, application software).
3. Computer Safety and Maintenance (Top Computer Mistakes Beginners Make, Basic Troubleshooting Techniques, Maintaining Your Computer).
4. Using the computer (Buttons and parts on a computer, setting up a computer, Computer safety and maintenance).
5. Introduction To Data Transmission And Computer Networking (Data Transmission, Data Transmission And Communication Facilities, Computer Network, Types Of Network, Network Configurations, The Internet And The Electronic Mail).
6. Introduction To Computer Programming (Flowchart And Algorithm, Introduction To The BASIC Programming Language)

DATA PROCESSING I - DAT 102

1. Introduction to Data Processing; Definitions, Types, Categories and Method of Data Processing, Basic Data processing, etc.
2. The Concept of Data and Information; Data processing system and Information System and their classification, Development of Information Management.
3. Data processing cycle; Areas and Stages of Data processing, Data Input, Storage, Output and Processing Techniques.
4. Data processing operations; Data Collection, Data Review, Data Entry, Data validation and types, Data processing Jobs and activities, Data types and Structures, Centralized and Decentralized Data processing Centres etc.

DATA PROCESSING II - DAT 103

1. Database Management; Definitions; Database, Database Management, Database Management System (DBMS).
2. DBMS Building Blocks.
3. DBMS Staff and their functions.
4. Data Tabulation and Presentation.
5. Data control and retrieval.
6. Batch Processing
7. Introduction to Database Design; Steps in Database Designing, Examples of Database Design, Methodology and Tables of Database Design, Logical database Design, Relational Database Design, Access Database Design, Hierarchical Database Design, Normalization, primary Key, Entity Relational Diagram, etc.
8. Data Analysis and Interpretation; Definition, Data Analysis Techniques, Steps and Examples in Data Analysis, Simple Data Analysis and Types, Methods of Data Analysis ,Data Analysis Reports, Working with Ms Excel, Basic Analysis with SPSS, etc.

COMPUTER OPERATIONS - DAT 104

1. Computer System; History and Classification, Computer Peripherals, Computer Hardwares and Softwares, workstations, etc.
2. Computer Networking.
3. Programming Languages.
4. Open and Closed Systems
5. Decision Support Systems and Decision making.
6. Information Technology.
7. Internet Concepts, etc.

COMPUTER PROGRAMMING - DAT 105

1. Introduction to Programming
2. Primitive Types and Variables
3. Operators and Expressions
4. Console Input and Output
5. Conditional Statements
6. Loops
7. Arrays
8. Methods
9. Recursion
10. Creating and Using Objects
11. Exception Handling
12. Strings and Text Processing
13. Defining Classes
14. Text Files

GENERAL METEOROLOGY - DAT 106

1. The layers and composition of the atmosphere: water vapour; carbon dioxide; etc. Vertical divisions of the atmosphere – troposphere; stratosphere; mesosphere; thermosphere; ionosphere.

2. Heat exchange processes in the atmosphere; solar and terrestrial radiation; Conduction and convection; advection; energy budget of the atmosphere; effect of radiation at the earth's surface; temperature difference between land and sea surfaces.

3. Elementary knowledge of synoptic and dynamic meteorology; air motion; Significance of scale; the winds and their causes; rudiments of the General circulation in the tropics and in non-tropical regions; local Winds; diurnal wind variation (breezes) and annual wind variations (monsoons); relation between the horizontal pressure gradient and the Winds; Buys-Ballot's law and the geostrophic wind; cyclones and Anticyclones; air masses and fronts; thunderstorms; synoptic chart analyses; Weather associated with synoptic systems.
4. Atmospheric temperature; horizontal and vertical variations of air Temperature, troposphere and stratosphere.
5. The effect of gravity on the atmosphere, air density, Atmospheric pressure, Variations in pressure; mean sea level pressure; horizontal and vertical pressures; significance of pressure gradient.
6. The three states of water; vapour pressure; saturation vapour pressure; evaporation, condensation; freezing; sublimation; isobaric and adiabatic processes; latent heat; Moisture indicators; relative humidity; mixing ratio and dew point.
7. Rudiments of cloud, fog and precipitation formation; visibility, the influence of water vapour, of water drops and dust (aerosols).
8. Basic knowledge of the vertical stability or instability; non-saturated air and saturated air; isobaric expansion and adiabatic expansion; the influence of condensation

G.STATISTICS - DAT 107

1. Data arrangement: Mean, median, mode, Mean of grouped and ungrouped data, Assumed Mean, Arithmetic and Geometric mean. Median and mode for grouped Data.
2. Graphical representation of data: Graphs, Pie chart, bar chart, Frequency table, cumulative frequency.
3. Applications: Daily and monthly means of weather elements like temperature, pressure, Humidity, etc.
4. Regression and Correlation, Scatter graphs, Relationships between two variables and scatter graphs (construction of line of best fit, estimate from scatter graphs, significance of the scatter graph, limitations of scatter graph); computing regression lines (equation of straight line, measuring the Deviations; graphing Regression lines; the use of regression lines; choice of regression line and Regression coefficient; Multiple linear regression and non–linear regression); Correlation (computation of r; interpretation of r; types of correlation; Spurious correlation; Rank correlation).

CLIMATOLOGY - DAT 108

1. Introduction, Clear distinction between weather and climate
2. Climatological elements, All elements of weather should be discussed, but emphasis on those which actually shape the climate of a place e.g.

temperature (including radiation), winds, humidity (including rainfall and air mass structure in the area)
3. Factors which can affects or modify the Climate of a place
4. Climatological Maps
5. The climatic regions of the world. The role of air masses in determining the major climatic regions of the world
6. Diurnal Variations of Temperature, Pressure, Wind Speed, etc
7. Introduction to General Circulation (Types of motions; Pressure and Wind patterns)
8. Air Masses, The two seasons in Nigeria, The prevailing winds and principal air masses
9. The climate of Nigeria, The ITD and its seasonal movements, Its role in determining the climate of various places in Nigeria
10. Weather zones in Nigeria, Climatological characteristics of each zone, Basis for the existence of the Weather zones
11. The length of the rainy and dry seasons with Nigeria as illustration, Approximate on-set dates (months) for the two major seasons in Nigeria (Rainy and dry seasons), Reasons for the variation of the on-set dates in Nigeria
12. Monsoon climate with definite seasonal pattern (wet and dry tropics), tropical climate, tropical arid and semi arid climates, temperate climate, polar climate,
13. Climatic scales, macro-, meso-, micro-climates
14. Climatic Classification; Climatic Regions of the World; Tropical and Equatorial, Tropical and Mid – latitude, Polar and Artic, Mountain Climates, Local Climates, Desert Climates, Acclimatization
15. Applied Climatology; Climate and Transport, Climate and Construction Climate and Water Resources, Climate and Agriculture, Climate and Business, Climate and Sports,climate and tourism
16. Processing of climatological data – application of statistical method
17. African climate, Climatology of basic meteorological systems for the African continent especially on a North – South axis in West and Central Africa
18. The monsoons of the world with specific reference to West Africa, East Africa and India.
19. Anthropogenic impact on the climate system in Nigeria.

5.8.5 CERTIFICATE COURSE IN AGROMETEOROLOGY

The above course is a five-month programme.

This course is designed to provide solutions relating to the problems of weather in agricultural practices. The objective is to train agricultural experts with competences require to in handling basic problems of agricultural practices as it relates to weather and climate.

S/N	COURSE	COURSE NAME	UNIT(S)

	CODE		
1	**AGR 101**	**Climatology**	3
2	**AGR 102**	**Hydro Meteorology**	3
3	**AGR 103**	**Statistics**	3
4	**AGR 104**	**General Meteorology**	3
5	**AGR 105**	**Satellite Meteorology**	3
6	**AGR 106**	**Meteorological Instruments**	4
7	**AGR 107**	**Agricultural Meteorology I**	4
8	**AGR 108**	**Agricultural Meteorology II**	4

LEARNING OUTCOMES ON CLIMATOLOGY

- To be able to understand the elements involved in regional and local climates
- To be able to classify climates
- To be able to understand and appreciate the local climates to region of responsibility and their roles
- To be able to understand the importance of the global atmosphere and its spatio-temporal variability
- To appreciate the geographical characteristics of their area
- To be able to understand tropical disturbances and their roles in weather processes and the ITD
- To appreciate the physical processes of energy transfer from the sun to the earth surface and its application

CLIMATOLOGY (AGR 101)

7. Definition of weather and climate. Techniques usually adopted in climatology.
   Climatic controls of a place and West Africa.
   Climatic Elements.
   Climatological elements. All elements of weather should be discussed, but emphasis on those which actually shape the climate of a place e.g. temperature (including radiation), winds, pressure, sky cover, radiation, precipitation, humidity (including rainfall and air mass structure in the area).

8. The climate of Nigeria
   The ITD-Definition and its seasonal movement. Its role in determining the climate of various places in Nigeria on a meridional axis.
   The seasons in Nigeria
   The length of the rainy and dry seasons in Nigeria
   The two seasons in Nigeria; the prevailing winds and principal air masses associated with each season. Relationship between winds and air masses.
9. Weather zones in Nigeria
   Climatological characteristics of each zone. Basis for the existence of the weather zones. Meridional movement of the ITD.

4. Regional climatology: geographical distribution of climates, Climatolography. Monsoon climate with definite seasonal pattern (wet and dry tropics). Climatic Classification
   Tropical climate
   Tropical arid and semi arid climates
   Temperate climate
   Polar climate
   Tundra, taiga
   topoclimate
5. Climatic statistics and Applications
6. Climate variability and Climate Change.

LEARNING OUTCOME ON HYDROMETEOROLOGY

- To understand the components of the water cycle and its applications.

Hydro Meteorology: (AGR 102)

9. Hydrology, Hydrometeorology; Definitions and Explanations. Water bodies of the world, Role of water in Economic Activities of nations.
10. Physical: properties of water cycle on the globe: physical properties of Water; the hydrological cycle on the earth; ground water; origin and Classification of ground water; physical properties of rocks in relationship to water; physical states and movement of ground water; ground water and its relationship to rivers; confined aquifer ground water and its role in the river feeding; Lakes and reservoirs; morphology of lakes; sources of inflow to lakes; water balance of lakes; dynamic phenomena on lakes (Waves and currents).
11. Heat regime of lakes; chemical composition of lake water; biological processes in Lakes; reservoirs, their regime and water balance; swamps; formation and classification of swamps; hydrological regime of swamps; formation and movement of glaciers, their influence on river inflow and regime.
12. River system; river basins; river valleys and channels; sources of river Flow; temperature regime of rivers; regime of river stages; movement of water in rivers; flow velocity; discharge in rivers, hydrograph analysis; sediment transport; chemical composition of river water; channel formation processes; water balance and runoff; units used to

measure runoff and flow; water balance and runoff units used to measure run off and flow; water balance of bodies of water.

13. Calculation of evaporation from the surface of basin;
    e. Average long-term annual runoff: distribution of annual runoff in
    f. Months and seasons; flow duration curves, mass diagrams and
    g. Storage Behaviour diagrams; maximum discharge and its calculation;
    h. Minimum flow and its calculation; sediment discharge and its calculation.
14. General alter Balance equation
15. Hydrograph Analysis Knowledge of flood regime of a stream, intelligent design of a wide. Variety of hydraulic structures such as bridges and culvert openings. Reservoir spillways and flood control works of all sorts

LEARNING OUTCOMES ON STATISTICS

- To analyse and interpret climatic data
- To understand the place of statistics in the use of weather and climate data

STATISTICS: (AGR 103)

8. Introduction: Definitions, meaning of statistics, examples with natural situations. Data collection and storage.
9. Data arrangement: Mean, median, mode; Mean of grouped and ungrouped data. Assumed Mean. Arithmetic and Geometric mean. Median and mode for grouped data Average mark.
10. Graphical representation of data: Pie chart, bar chart, Frequency table, cumulative frequency, Ogive.
11. Regression and Correlation

    Scatter graphs, relationships between two variables and scatter graphs (construction, line of best fit, estimate from scatter graphs significance of the scatter graph, limitations of scatter graph). Regression lines (definition, equations of approximating curves i.e. exponential and polynomial curves); computing regression lines (equation of the line or straight line; method of least squares, measuring the deviations; the regression of y on x; the regression of x on y; graphing regression lines; the use of regression lines; choice of regression line and Regression coefficient). Correlation (computation of r; interpretation of r; types of correlation; Spurious correlation; Rank correlation r^{2}. Applications to time series graphing the data; the equation of a least square line and fitting the data; estimates. Multiple linear regression and non–linear regression.
12. Probability

    Introduction: Definitions of probability, events and various classes of events; trials and random variables and probability symbols. Conditional probability; independent and dependent event; mutually exclusive events; mathematical expectation; permutations and combination. Probability distributions, the binomial distribution (a short-cut i.e. P(X) =nCx Pxq (n-n), when can it be used, mean and standard deviation of Binomial distribution, some properties, the Poisson distribution (Poisson distribution,

when it can be used, mean and standard deviation of the Poisson distribution and some properties and the Normal distribution some properties of the Normal distribution, the relationship between binomial and normal distribution.

13. Estimation

Tests of significance; testing a hypothesis (the null hypothesis, testing the Null hypothesis, rejection of the null hypothesis, non-rejection of the Null hypothesis, confidence level and the risk of rejecting a true hypothesis, Confidence level and the risk of not rejecting an incorrect hypothesis; type I and II errors; one-fact and two-tail tests. Testing the difference between means and properties (Distribution of the difference between properties).

14. Small Sampling Theory

Small Samples; "Student's" t-distribution, confidence intervals; Test of hypothesis and significance; the chi-square distribution; Confidence intervals for x^2 degree of freedom.

LEARNING OUTCOMES ON GENERAL METEOROLOGY

- to appreciate the physical structure of the atmosphere
- to enable the student to understand the physical processes of energy transfer from the sun to the earth surface and its application
- the principles of atmospheric pressure and its roles in the study of the atmosphere and aviation in specific/weather occurrence
- the principles of atmospheric temperature and its roles in the study of the atmosphere/climate variability
- to understand the importance of humidity in the study of the atmosphere
- to understand movement of air constituents
- to understand the concept of air flow and its effect to weather development
- to be able to understand the formation and effect of hazardous weather

GENERAL METEOROLOGY: (AGR 104)

11. The composition and structure of the atmosphere: Saturated or unsaturated atmosphere ; atmospheric ozone; water Vapour; carbon dioxide; thermosphere; interplanetary gas; Vertical divisions of the atmosphere; Troposphere; Stratosphere; Mesosphere; Thermosphere; Ionosphere.

12. Heat exchange processes in the atmosphere; solar and terrestrial radiation; Conduction and convection; advection; mechanical, thermal, turbulence and clear air turbulence; energy budget of the atmosphere; effect of radiation at the earth's surface; temperature difference between land and sea surfaces(land and sea breeze).
13. Air temperature; basic principles of temperature measurements; Celsius, Fahrenheit and Kelvin temperature scales, Thermometers, physical processes used in thermometry, types; thermograph, measurement of air temperature; exposure; horizontal and vertical variations of air Temperature.
14. The effect of gravity on the atmosphere, air density, Atmospheric pressure, units; measurement; the hydrostatic equation; Horizontal and vertical variation of pressure; pressure to sea level; the ICAO Standard atmosphere; the barometer used as an altimeter; Diurnal variation of pressure; Pressure gradient and its significance.
15. Moist air; the three states of water, solid, liquid and gaseous; density; Water vapour pressure; saturation vapour pressure; evaporation Condensation; freezing; sublimation; latent Heat
16. Moisture indicators; relative humidity; mixing ratio and dew point; water Vapour pressure
17. Elementary theory of the wet-bulb thermometer; principles of the Psychrometer and The hygrometer; rudiments of cloud, fog and precipitation. Formation and visibility. The effect of aerosols (fog and dust on visibility).
18. Expansion or compression of a rising or falling air parcel; variation of the parcel temperature with height; isobaric expansion and adiabatic expansion; the influence of condensation; basic knowledge of the vertical stability; non-saturated air and saturated air.
19. Forces that affect atmospheric motion e.g pressure gradient force, gravity force, Coriolis Effect and friction.
20. Elementary knowledge of synoptic and dynamic meteorology; air motion; Significance of scale; the winds and their causes; rudiments of the general circulation in the tropics and in non-tropical regions; local winds; diurnal wind variation (breezes) and annual wind variations (monsoons); relation between the horizontal pressure gradient and the Winds; Buys-Ballot's law and the geostrophic wind; cyclones and Anticyclones; air masses and fronts; ITD and thunderstorms.

LEARNING OUTCOMES ON SATELLITE METEOROLOGY

- To be able to identify hydrometeors and their method of observation
- To be able to conduct necessary observations and understand the techniques
- To be able to identify the various synoptic features of meteorological charts and imageries and their effects
- To be able to identify clouds and their associated characteristics and formation

SATELLITE METEOROLOGY (AGR 105)

19. Basics in remote sensing Physics behind remote-sensing

20. Introduction to History of meteorology satellites
21. Satellites-data acquisition, processing and archiving
22. Satellite orbits, characteristics and radiometers
23. Satellite data acquisition, processing and data management.
24. Satellite image analysis, display and interpretation
25. Application of satellite imagery both in the visible and infrared
26. Regions for the analysis and interpretation of weather systems.
27. Case-studies, that is, a series of practical examples to examine a range of Meteorological events over the African continent, tropics and mid-latitude with emphasis on the application of satellite Meteorology to public weather forecast, Aeronautical Meteorology and Agro-meteorology.
28. Future of satellites meteorology

LEARNING OUTCOMES OF METEOROLOGICAL INSTRUMENTS

- The students should be able to know the factors of siting the instruments and spacing of instruments

- They should be able to understand the underlying principle of the instruments in relation to units and dimensions and their mode of operation

- They should be able to conduct necessary observations and understand the techniques

METEOROLOGICAL INSTRUMENTS & MAINTENANCE: (AGR 106)

1. Direct and Indirect Meteorological measurement
   Measurement of meteorological variables
   Specific features of Meteorological Measurement
   Direct Reading Instruments: Thermometers, Barometer, Wind Vane, Cup-Counter Anemometer, Class A Pan, Gunn Bellani Radiation Integrator, Raingauge, Sunshine Recorder and Ordinary Anemometer.
   Autographic Instrument (Indirect Reading Instruments): Thermograph, Barograph, Hyetograph and Hygrograph. Desirable Characteristics of Meteorological Instruments (Accuracy, durability and reliability).
   General requirements for sitting and exposure of Meteorological Instruments.
2. Measurement of atmospheric pressure
   Nature of atmospheric pressure – Units of measurements; Principles underlying the operation of atmospheric pressure measuring
   Instruments; Mercury barometers; Kew Pattern Barometer and Fortins Barometer; Aneroid barometers; analogue and digital; The Principle of the barograph; Exposure of atmospheric pressure measuring instruments.
3 Measurement of air temperature; Nature and units of measurement of air temperature, temperature scales used in Meteorology and conversion. Principles underlying the operation of air – temperature measuring; Instruments; Mercury-in-glass thermometers, spirit-In-glass

thermometers; The bimetallic thermometers, station thermograph ; Exposure of air temperature measuring instruments (source of errors); Re-Setting of thermometers.

4 Measurement of atmospheric humidity; Nature and units of measurement of absolute humidity, relative humidity and dew point and other humidity parameters; General principles of hygrometers. Humidity measuring instruments based on change of dimension of Hygroscopic substances - the hair hygrometer, the psychrometer. Automated psychrometer and recording Psychrometer.

5 Measurement of surface wind direction and speed; Wind direction and wind speed – specific feature units of measurement; Principles of wind measuring instruments; The pressure plate anemometer; Cup counter Anemometer- The rotation sensor cup – wheel – propeller; and Anemometers measuring run of wind.

6 Measurement of precipitation; General liquid and solid precipitation – units of measurement; Principles of the Point measurement of precipitation. Non – recording precipitation gauges – daily rain gauges of the unshielded and shaded types. Recording precipitation gauges – siphon (float type – tipping bucket and Weighing – balance type Exposure requirements concerning precipitation point – measurement instruments. Routine care of precipitation measuring instruments; Factors affecting the accuracy of point – precipitation measurements (Evaporation Loss). Measurement of evaporation

7. General units of measurements, Principles of evaporation measuring Instruments, the evaporation pan: Class A Pan – (the hook gauge type). General requirements for the evaporation – measuring instruments' exposure, routine care of evaporation – measuring instrument.

8 Sunshine duration measurement
General principles of sunshine duration measurement
The Campbell Stokes sunshine duration recorders. Sitting and exposure requirements for sunshine duration measuring
Instruments, factors affecting the sunshine records (Cloud cover, Precipitation). Routine care of the Campbell Stokes sunshine recorder.

9 Automation of the measurement of Meteorological variables. Technical and economic aspects of automation objectives. Classification of automatic weather stations. Basic block diagram of an automatic weather station. Sensors used with automatic weather stations. Maintenance of automatic weather stations. Reliability of automatic equipment. Standard, quality control, calibration and inter comparison.

LEARNING OUTCOME FOR AGROMETEOROLOGY

- To understand the effect of meteorological and climatic data to crops and livestock
- To employ meteorological information to improve agricultural products

AGROMETEOROLOGY I: (AGR 107)

21. Definition, scope and aims of Agrometeorology and other allied disciplines.

22. The relationship between weather, climate and agriculture as it affects soil, plants, farm animals, pests and diseases. Pest of crops and animals, farm building and equipment.
23. Artificial modifications of the Meteorological and Hydrological regimes namely; glass green houses, windbreaks, and shelter belts, irrigation, mulching.
24. The history of Agriculture and its relationship with association science. Agricultural Ecology and Ecosystem Distribution and Classification of Vegetation belts in Nigeria. Weather and climatic modification.
25. General production practice of field crops, crop production e.g. Maize Production factors for optimum yield of field crops. Factors affecting crop yield; Environmental factors – rainfall, CO_2, temperature, radiation, wind, light, evaporation water supply, nutrient, weed, pest and disease soil physical condition. Plant population, field of individual plant and community.
26. Plant protection definition of pest, important of pest. Importance of plant protection. Types of Pests: Polyphagous pest, Locusts, Termites, Bihar hairy Caterpillar, Cutworm, Greasy Cutworm, Damage caused by locust phase. Theory of locust, life cycle of locusts and control. Observations on crop pests and diseases.
27. Factors affecting disease development and propagation (the role of the macro-climatic environment) namely, temp, humidity, soil pH, wind, soil texture.
28. Control of plant diseases
    Cultural methods
        . Proper selection of geographical area
        . Selection of field
        . Choice of time of sowing
    Exclusion method
        Eradication
        . Rogueing
        . Crop sanitation
        . Eradication of alternate and collateral hosts
        . Heat and Chemical treatments of diseased plants
        . Biological control
29. Pests of Crop plants
    Insect pests (the classification based on habits and parts of plants attached) barriers, sucking insects, leaf eating insects, fruit and seed eaters etc.
    Other Pests such as Birds, Rodents and Monkeys
30. Diseases of Crop Plants
        Fungal diseases
        Bacterial diseases
        Viral diseases
        Poultry diseases
        Symptoms and control

31. Phenology Definition of phenology Method of phonological observations. Different phases of phenological observations in different crop plants. Biological Observations (Phenological observations)

Phonological phases in cereals
Germination
Emergence sprouting
Tillering
flowering
earning
milky ripeness
waxy ripeness
Tisselling

Importance of phenological observations

32. Agrometeorological elements and their methods of observations.
33. Definition, climatic elements, Biological elements, conditions of observation, Agrometeorological station and Networks, Observation of physical elements, Observation of biological Character/Elements, Detail observation of high accuracy.
34. Prevention and mitigation of Agrometeorological calamities in Nigeria.
35. Evapotransition Studies .
36. Agrometeorological water balance

P + I =ET + R + D + S

Evaporation
Evapotranspiration (Actual and Potential)
Factors affecting evapotranspiration
Factors affecting evapotranspiration
Calculation and Measurements of evapotranspiration
Water balance: Lysimetry
Aerodynamic profile approach (Bowen into
Combination methods (Penman equation)
The use of evapotranspiration data.

37. Soil Water

Soil water availability
3 categories of soil water
Capillary
Hygroscopic
Gravitational
Field capacity
Wilting point
Soil water in relation to plant growth.
Plant response to water deficit and excess moisture
The need for soil Moisture

38. Agrometeorological stations

Classification
Principal
Ordinary
Auxiliary
Agromet station for specific purposes

39. Climatic normal for livestock's: poultry birds, Goat, Sheep, Pigs and Cattle. Meteorological equipment of crop plants for rice, sugar cane, cotton, maize, potatoes etc. Animal's production systems, uses of animals. Outdoor animals and Meteorological elements.

40. Water and the Hydrological Cycle in Agriculture moisture characteristics of soil water and vegetation. Determination of water loss from land surface fundamental of the evaporation process. Existing methods of determining evaporation Energy balance of estimating evaporation. Aerodynamic estimation of evaporation combination model methods of penman and others. Development of original penman equation. Evaporation formulae of priestle – Taylor and Penman – Monteith special forms of precipitation Dew, Snow, soil moisture Budgets – Irrigation needs

AGRICULTURAL METEOROLOGY II (AGR 108)

8. The History of Agriculture and its relationship with associated science. The relationship between Agriculture and weather elements. Weather and climatic modification for sustainable and affordable agriculture.
9. General production practice of field crops, crop production e. g Maize; Production factors for optimum yield of field crops. Factors affecting crop yield; Environment factors – rainfall, co2, temperature, Radiation, wind, light, evaporation water supply, nutrient, weed, pest and Disease soil physical condition. Plant population, Field of individual plant and community.
10. Phenology. Definition of phenology. Method of phonological observations. Different phases of phonological observation in different crop plants.
11. Agro-meteorological elements and their methods of observations. Definition, climatic elements, Biological elements, condition of observation, Agro-meteorological station and Networks, Observation of physical elements, Observation of biological Character/ Elements, Detail observation of high accuracy.
12. Climatic normal for livestock:- Poultry birds, Goat, sheep, pigs and cattle. Meteorological equivalent of crop plants for rice, sugar cane, cotton, maize, Potatoes etc. Animal production systems. Uses of animals. Outdoor animals and Meteorological elements.
13. Water and the Hydrological Cycle in Agriculture moisture characteristics of Soils water and vegetation. Determination of water loss land surface Fundamental of the evaporation process. Existing methods of determining evaporation Energy balances of estimating Evaporation Aerodynamic estimation of evaporation combination model methods of Penman and others. Development of original Penman equation. Evaporation formulae of Priestle – Taylor and Penman- Monteith special forms of precipitation Dew, snow, soil moisture Budgets – Irrigation needs.
14. Observations of crop pests and diseases, Factors affecting disease development and propagation (the role of the Macro-climatic environment namely temperature, humidity, soil pH, wind, soil Texture, etc.), Control of plant diseases (Cultural methods, Exclusion method, Eradication method, Heat and Chemical treatments of diseased plants, Biological control), Identification of Crop / plant pests and diseases. Diseases of Crop Plants (Fungal diseases, Bacterial diseases, Viral diseases), Poultry diseases (Symptoms and control)

5.8.7 CERTIFICATE COURSE IN AVIATION METEOROLOGY

The above course is a four-month programme.

Under the semester arrangement it has just 1 semester. It is designed by RTC to train high level manpower with a complete competence in aviation meteorology.

S/N	COURSE CODE	COURSE NAME	UNIT(S)
1	**AER 101**	**Aeronautical Meteorology I**	3
2	**AER 102**	**Aeronautical Meteorological II**	4
3	**AER 103**	**Synoptic Meteorology**	3
4	**AER 104**	**Codes & OBS**	3
5	**AER 105**	**Dynamic Meteorology**	3
6	**AER 106**	**Synoptic Analysis & Current Weather**	2
7	**AER 107**	**Satellite Meteorology**	3

LEARNING OUTCOMES FOR AERONAUTICAL METEOROLOGY I

- Familiarize students to terminologies in aeronautical meteorology.
- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to understand the various aviation meteorological hazards and to know what to do to ameliorate the effect of such hazards on operation of aircrafts.
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

AERONAUTICAL METEOROLOGY I (AER 101)

16. Definitions of Terms: Aeronautical Meteorology, Meteorological report, observation, visibility, runway visual range. Altitude, elevation height, aerodrome elevation, flight level, transition level, and aerodrome meteorological minima

17. Observing techniques. Surface wind direction and speed, including changes and variations. Visibility and runway visual range, including spatial and temporal variations in RVR observations, cloud amount, height and type and spatial and temporal variations. Vertical visibility, observations using automatic instruments such as ceilometers. Pressure measurements for the purpose of determining QFE and QNH.
18. Reporting, coding and dissemination of weather information. Complete knowledge of international meteorological codes related to observations such as METAR and SPECI. Knowledge of procedure for dissemination of weather information at the aerodrome, including the special needs of ATC units. Knowledge of the procedures for the preparation of the plain language forms of meteorological messages.
19. Hazardous phenomena: Aircraft icing. Elementary knowledge of icing types; formation, accretion rates and association of icing with clouds; turbulence, elementary knowledge of turbulence near the ground as related to topography; elementary knowledge of high level turbulence (CAT) and its association with jet streams. Wind shear and volcanic ash.
20. Introduction to the responsibilities of ICAO and WMO in aeronautical meteorology.
21. Aeronautical telecommunications. Elementary understanding of the general organization of aeronautical telecommunications, but they should have a good working knowledge of the operation of the aeronautical fixed service.
22. WMO documents: Technical regulations, (WMO-No 49) Vol II – Meteorological service for International Air Navigation. Manual on codes (WMO-No 306). Guide to Meteorological Instruments and methods of observation (WMO-No 8). Weather reporting (WMO-No 9).

AERONAUTICAL METEOROLOGY - AER 102 (4UNITS)

Terminal Aerodrome Forecasts (TAFs)

Aerodrome warnings

Windshear warnings

Significant Meteorological Information (SIGMET

Weather Briefing and flight documentations

Area Forecasts

LEARNING OUTCOMES FOR AERONAUTIC METEOROLOGY II

- Familiarize students to terminologies in aeronautical meteorology.
- Gain in depth knowledge in different aviation meteorological reports and to be able to make such reports.
- Ability to issue aviation reports for safety of aircrafts
- Get introduced to the responsibilities of ICAO, WMO and National Meteorological and Hydrological Services (NMHS) in aviation industry

LEARNING OUTCOMES FOR SYNOPTIC METEOROLOGY

- To Be Able To Identify Clouds And Their Associated Characteristics And Formation
- To Be Able To Understand The Importance Of The Global Atmosphere And Its Spatio-Temporal Variability
- To Be Able To Identify The Various Synoptic Features Meteorological Charts And Imageries And Their Effects
- To Be Able To Understand Tropical Disturbances And Their Roles In Weather Processes And The ITD
- To Be Able To Understand The Connection Between Tropical And Extra-Tropical Systems
- To Understand The Processes Leading To Cloud Formation And Triggering Processes/ Propagation And Regeneration

- To Be Able To Understand The Concept Of Mesoscale Systems In The Tropics
- To Be Able To Understand And Explain The Concept Of Airmasses And The Modification.
- To Be Able To Identify The Hazardous Weather Situations And Their Socio-Economic Importance To The Area Of Consideration

SYNOPTIC METEOROLOGY (AER 103)

23. Introduction and Definition of Synoptic Meteorology.
24. ITD and the associated weather zones. Waves and jet streams, land and Sea breeze, anabatic and Katabatic winds. Evolution and Dynamics of west African line squall.
25. Tropical Weather systems. Trade inversions trade winds, Tropical/subtropical jet streams, and other broad wind systems. Rainfall, Tropical cyclones, monsoons. Characteristic patterns of cloud associated with easterly waves, seasonal evolution of the tropical wind systems, and the inter-tropical convergence zone; annual cycles.

26. Mid-latitude synoptic systems. Air-mass concept; source areas; formation processes for air-masses. Air-mass modification; thermodynamic and dynamic changes; boundary/interface between two adjacent air masses; the slope of steady-state frontal zones; frontal-wave depression.
27. General circulation

LEARNING OUTCOME ON CODES & OBSERVATION I

- To be able to identify and understand the principle behind the formation and associated weather events
- Ability to collate climatic data for research purposes
- To be able to identify hydrometeors and their method of observation
- To be able to code and transmit information
- Ability to collate climatic data for research purposes
- To be able to conduct necessary observations and understand the techniques
- To be able to identify clouds and their associated characteristics and formation

. CODES AND OBSERVATIONS I: (AER 104)

32. Brief introduction to instrument used in taking meteorological observations.
33. Measurement of meteorological variables and procedure of observation, Specific features of Meteorological measurements; Direct and Indirect. Measurement of Temperatures; Air, Maximum, Minimum etc. Measurement of Humidity; Relative Humidity autographic instruments, derived values with the aid of Humidity slide rule, Measurement of Atmospheric Pressures (Barometers,) Barographs).
34. Measurement of Clouds; Types, Amount and Height (Ceilometers, ceiling Ascent, Cloud, Atlas and Pictures)
35. Measurement of surface Winds. Direction and speed; (Anemometers, and Beaufort scale for estimation).
36. Precipitation Measurements (Rates and Records of precipitation) Solid or Liquid, Gauges units. Precipitation (Amount and Duration). Automated weather station for intensity.
37. Measurement of Evaporation – Piche Evaporimeters
38. Visibility; General unit measurements, Definition of visibility (hydrometeor and lithometoes) and Visibility at night. Prevailing visibility/ directional visibility
39. Measurement of solar radiation (Sunshine recorders, Gunn Bellani radiation integrator and solarimeter).
40. Methods and procedures of observations Standard time, accuracy and measurement (UTC unit) Standard International Block and stations numbers e.g. Nigerian Stations.
41. Codes: Applications of SYNOP code for observation Section O -5
42. Present weather, Visibility and (Direction and speed), Application of METAR and SPECI Codes.
43. introduction to "9" special phenomenon groups i.e. 9spspspsp of synoptic message

44. Introduction to supplementary information groups of synoptic message e.g 5j1j2j3j4, 4ffff, 55408, 4esss etc.
45. section 5 555 of synoptic message e.g. 1sntxtxtx 2sntntntn 30uuu 40rrr
46. METAR modifications and corrections

SPECI modifications and corrections

LEARNING OUTCOME ON DYNAMIC METEOROLOGY

- To be able to identify the hazardous weather situations and their socio-economic importance to the area of consideration
- To be able to understand the concept of mesoscale systems in the tropics
- To understand the concept of air flow and its role of wind and its effect to weather development
- To be able to understand and explain the concept of airmasses and the modification.
- To be able to understand the connection between tropical and extra-tropical systems

DYNAMIC METEOROLOGY (AER 105)

1. Concept of dynamic meteorology compared with synoptic and Physical Meteorology, physical dimensions and units.
2. Atmospheric scales; pressure gradient, gravitational, centrifugal, gravity and coriolis forces, equation of motion in a simple form, geostrophic wind, wind and pressure near the equator; gradient wind and comparison with geostrophic wind, trajectories and streamlines, cyclostrophic wind; flow within the planetary boundary layer (cross-isobaric flow)
3. Ageostrophic and Isallobaric winds. Hydrostatic equilibrium and Hypsometric equation and uses. Thermal wind, divergence, convergence and vertical motion. Intensification and deepening of pressure systems. Vorticity (relative and absolute). Formation of cyclones and anti cyclones. Turbulence and gustiness, eddies and vertical transport of matter, clear-air turbulence.

LEARNING OUTCOMES ON SYNOPTIC ANALYSIS & CURRENT WEATHER

- To be able to identify and understand the principle behind the formation and associated weather events
- To be able to understand the concept of weather developments at different scales over point location
- To be able to identify the various synoptic features, meteorological charts and imageries and their effects
- To be able to identify the various synoptic features meteorological charts and imageries and their effects
- To be able to evaluate the recent technology used for the display of weather systems, their benefits and shortcomings

SYNOPTIC ANALYSIS & CURRENT WEATHER (AER 106)

28. Definition of various Isolines
29. Rules governing Analysis/Nature of Analysis
30. Types of Charts used in Analysis
31. Analysis of various elements (Surface and Upper Air)
32. -Temperature, Wind, Humidity, Dew point, Divergence, Vorticity etc
33. Introduction to Numerical weather Prediction
34. Tephigram: Analysis & Interpretation

LEARNING OUTCOMES ON SATELLITE METEOROLOGY

- To be able to identify hydrometeors and their method of observation
- To be able to conduct necessary observations and understand the techniques
- To be able to identify the various synoptic features of meteorological charts and imageries and their effects
- To be able to identify clouds and their associated characteristics and formation

SATELLITE METEOROLOGY (AER 107)

29. Basics in remote sensing Physics behind remote-sensing
30. Introduction to History of meteorology satellites
31. Satellites-data acquisition, processing and archiving
32. Satellite orbits, characteristics and radiometers
33. Satellite data acquisition, processing and data management.
34. Satellite image analysis, display and interpretation
35. Application of satellite imagery both in the visible and infrared
36. Regions for the analysis and interpretation of weather systems.
37. Case-studies, that is, a series of practical examples to examine a range of Meteorological events over the African continent, tropics and mid-latitude with emphasis on the application of satellite Meteorology to public weather forecast, Aeronautical Meteorology and Agro-meteorology.
38. Future of satellites meteorology

5.8.9 CERTIFICATE COURSE IN METEOROLOGICAL INSTRUMENT

The Tailored Certificate Course in Conventional Meteorological Instrument will be satisfied through successful completion of the following curriculum for Conventional Meteorological Instrument Course:

S/N	COURSE CODE	COURSE NAME	UNIT(S)
1	**MIC 101**	**Computer Studies**	2
2	**MIC 102**	**Fault Findings**	2
3	**MIC 103**	**General Meteorology**	3
4	**MIC 104**	**Met**	4

		Instruments/Maintenance	
5	**MIC 105**	**Met Instrument Calibration & Quality Control**	3
6	**MIC 106**	**Meteorological Statistics**	3

COURSE OUTLINES FOR CERTIFICATE COURSE IN METEOROLOGICAL INSTRUMENT

COMPUTER STUDIES – MIC 101

1. Evolution of the computer systems: Definitions of computer; History of the computer (The beginning of computer age); Generations of computers; Types of computers; Classifications of digital computers; Characteristics of computers; Application of computers in the society.
2. Functional parts of a digital computer: Hardware (Input units, Output units, Processing units, Storage units, Communication units) and software (types of computer software, operating system, application software).
3. Computer Safety and Maintenance (Top Computer Mistakes Beginners Make, Basic Troubleshooting Techniques, Maintaining Your Computer).
4. Using the computer (Buttons and parts on a computer, Setting up a computer, Computer safety and maintenance).
5. Introduction To Data Transmission And Computer Networking (Data Transmission, Data Transmission And Communication Facilities, Computer Network, Types Of Network, Network Configurations, The Internet And The Electronic Mail).
6. Introduction To Computer Programming (Flowchart And Algorithm, Introduction To The BASIC Programming Language)

FAULT FINDING – MIC 102

1. Introduction
2. Maintenance and the user
3. Preparation prior failure
4. fault-finding fundamentals
5. Health and safety essentials
6. Fault-finding techniques
7. Component replacement
8. Test equipment
9. Out on your own
10. Further reading.

GENERAL METEOROLOGY – MIC 103

1. The layers and composition of the atmosphere: water vapour; carbon dioxide; etc. Vertical divisions of the atmosphere – troposphere; stratosphere; mesosphere; thermosphere; ionosphere.

2. Heat exchange processes in the atmosphere; solar and terrestrial radiation; Conduction and convection; advection; energy budget of the atmosphere; effect of radiation at the earth's surface; temperature difference between land and sea surfaces.
3. Elementary knowledge of synoptic and dynamic meteorology; air motion; Significance of scale; the winds and their causes; rudiments of the General circulation in the tropics and in non-tropical regions; local Winds; diurnal wind variation (breezes) and annual wind variations (monsoons); relation between the horizontal pressure gradient and the Winds; Buys-Ballot's law and the geostrophic wind; cyclones and Anticyclones; air masses and fronts; thunderstorms; synoptic chart analyses; Weather associated with synoptic systems.
4. Atmospheric temperature; horizontal and vertical variations of air Temperature, troposphere and stratosphere.
5. The effect of gravity on the atmosphere, air density, Atmospheric pressure, Variations in pressure; mean sea level pressure; horizontal and vertical pressures; significance of pressure gradient.
6. The three states of water; vapour pressure; saturation vapour pressure; evaporation, condensation; freezing; sublimation; isobaric and adiabatic processes; latent heat; Moisture indicators; relative humidity; mixing ratio and dew point.
7. Rudiments of cloud, fog and precipitation formation; visibility, the influence of water vapour, of water drops and dust (aerosols).
8. Basic knowledge of the vertical stability or instability; non-saturated air and saturated air; isobaric expansion and adiabatic expansion; the influence of condensation

METEOROLOGICAL INSTRUMENTS INSTALLATION /MAINTENANCE– MIC 104

1. Measurement of meteorological variables, Specific features of Meteorological Measurement, Direct and indirect Meteorological measurement, Direct Reading Instruments, Indirect Reading Instruments, Desirable Characteristics of Meteorological Instruments, General requirements for sitting and exposure of Meteorological Instruments.
2. Measurement of atmospheric pressure, Units of measurements of atmospheric pressure, Principles underlying the operation of atmospheric pressure measuring Instruments (Mercury barometers, Kew Pattern Barometer and Fortin Barometer, Aneroid barometers, barographs), Exposure of atmospheric pressure measuring instruments.
3. Measurement of air temperature, units of measurement of air temperature, temperature scales used in Meteorology and conversion, Principles underlying the operation of air – temperature measuring Instruments (Mercury-in-glass thermometers, spirit-In-glass thermometers, The bimetallic thermometers, thermographs), Exposure of air temperature measuring instruments – radiation errors, Setting time of thermometers.
4. Measurement of atmospheric humidity, units of measurement of absolute humidity, relative humidity, dew point and other humidity parameters. General principles of hygrometers. Humidity measuring instruments based on change of dimension of Hygroscopic substances (the hair hygrometer, the psychrometer).

5. Measurement of surface wind direction and speed, units of measurements of wind direction and wind speed, Principles of wind measuring instruments (The pressure plate anemometer, The rotation sensor cup – wheel – propeller, Anemometers measuring run of wind).
6. Measurement of precipitation (liquid and solid precipitation), units of measurement, Principles of the Point measurement of precipitation, Non – recording precipitation gauges (daily rain gauges of the unshielded and shielded types), Recording precipitation gauges (siphon, float type, tipping bucket, Weighing balance type), Exposure requirements concerning precipitation point – measurement instruments, Routine care of precipitation measuring instruments, Factors affecting the accuracy of point – precipitation measurements.
7. Measurement of evaporation, General units of measurements, Principles of evaporation measuring Instruments (evaporation pan: Class A Pan, the hooked – gauge type, etc.), General requirements for the evaporation measuring instruments' Exposure, routine care of evaporation – measuring instruments.
8. Sunshine duration measurement, General principles of sunshine duration measurement, The Campbell Stokes sunshine duration recorders, Sitting and exposure requirements for sunshine duration measuring instruments; factors affecting the sunshine records of the Campbell Stokes instrument, Routine care of the Campbell Stokes sunshine recorder, measurement of burnt trace on the cards.
9. Automation of the measurement of Meteorological variables, Technical and economic aspects of automation objectives, Classification of automatic weather stations, Basic block diagram of an automatic weather station, Sensors used with automatic weather stations, Maintenance of automatic weather stations, Reliability of automatic equipment.

METEOROLOGICAL INSTRUMENTS FABRICATION &CALIBRATION (BIP 105)

Concepts of fabrication and workshop safety rules, Essential fabrication tools used in marking out (rules, dividers, micrometer, scribers), measurement (ruler, venier, micrometer), sawing (hacksaw, piercing saw), filing (hand file, flat file, and drilling, Types of fabrication processes and techniques (e.g. cutting, bending, folding, welding, punching. Raw materials used in fabrication e.g. plate, metal tube stock formed and expanded metal, fittings, castings, welding rods. Technological innovations in fabrication e.g. use of computer aided design and detailing system (CAD), computer aided manufacturing machinery (CAM) etc. Essential components of measurement system, measurement unit and standards, static characteristics of a measurement system (accuracy and precision, repeatability, reproducibility, tolerance, sensitivity of measurement, threshold, resolution, range or span, traceability, concepts of errors and uncertainty in measurements, principles of calibration in measurement.

STATISTICS – MIC 106

1. Data arrangement: Mean, median, mode, Mean of grouped and ungrouped data, Assumed Mean, Arithmetic and Geometric mean. Median and mode for grouped Data.

2. Graphical representation of data: Graphs, Pie chart, bar chart, Frequency table, cumulative frequency.

3. Applications: Daily and monthly means of weather elements like temperature, pressure, Humidity, etc.
4. Regression and Correlation, Scatter graphs, Relationships between two variables and scatter graphs (construction of line of best fit, estimate from scatter graphs, significance of the scatter graph, limitations of scatter graph); computing regression lines (equation of straight line, measuring the Deviations; graphing Regression lines; the use of regression lines; choice of regression line and Regression coefficient; Multiple linear regression and non–linear regression); Correlation (computation of r; interpretation of r; types of correlation; Spurious correlation; Rank correlation).

COURSES FOR PUBLIC WEATHER PRESENTER

S/N	COURSE CODE	COURSE TITLE	UNITS
1	PWS 101	Physical Meteorology	4
2	PWS 102	Meteorological Instruments	4
3	PWS 103	Codes & Obs	3
4	PWS 104	Synoptic Meteorology	3

These are initial courses at RTC for one month before migrating to Abuja CFO.

Courses and Course Contents

LEARNING OUTCOMES ON PHYSICAL METEOROLOGY

To understand movement of air constituents

- To be able to identify clouds and their associated characteristics and formation
- To understand the processes leading to cloud formation and triggering processes/ propagation and regeneration
- To understand their formation and effect in the hazardous weather
- To appreciate the concept of atmospheric phenomenon
- To be able to identify hydrometeors and their method of observation

PHYSICAL METEOROLOGY (PWS 101)

1. Introduction to the subject
2. Definitions, Clouds, Fog and precipitation. Basic knowledge of their Formation. Fog classification and artificial rain, visibility, meteors.
3. Influence of the surface tension of rain drops and of the hygroscopicity of the nuclei on saturation pressure;
4. Process of raindrop formation.
5. Cooling of the air due to adiabatic and non-Adiabatic processes.
6. Cloud structure and evolution dynamics.
   i. Frontally generated cloud
   ii. Cumuliform clouds
   iii. Orographic clouds
   iv. International cloud classification

7. Static Electricity and Electrostatic phenomenon -
   i. Elements of Atmospheric Optics and Electricity, Refraction, rainbow, Halo, Corona Blue sky.
   ii. Transparency of the atmosphere. Types of atmosphere – Constant lapse rate, Homogenous, Isothermal and Adiabatic.
   iii. Relationship between static electricity and atmospheric phenomena.
   iv. Lightning discharge and thunderstorms.

METEOROLOGICAL INSTRUMENTS INSTALLATION /MAINTENANCE– MIC 102

1. Measurement of meteorological variables, Specific features of Meteorological Measurement, Direct and indirect Meteorological measurement, Direct Reading Instruments, Indirect Reading Instruments, Desirable Characteristics of Meteorological Instruments, General requirements for sitting and exposure of Meteorological Instruments.
2. Measurement of atmospheric pressure, Units of measurements of atmospheric pressure, Principles underlying the operation of atmospheric pressure measuring Instruments (Mercury barometers, Kew Pattern Barometer and Fortin Barometer, Aneroid barometers, barographs), Exposure of atmospheric pressure measuring instruments.
3. Measurement of air temperature, units of measurement of air temperature, temperature scales used in Meteorology and conversion, Principles underlying the operation of air – temperature measuring Instruments (Mercury-in-glass thermometers, spirit-In-glass thermometers, The bimetallic thermometers, thermographs), Exposure of air temperature measuring instruments – radiation errors, Setting time of thermometers.
4. Measurement of atmospheric humidity, units of measurement of absolute humidity, relative humidity, dew point and other humidity parameters. General principles of hygrometers. Humidity measuring instruments based on change of dimension of Hygroscopic substances (the hair hygrometer, the psychrometer).
5. Measurement of surface wind direction and speed, units of measurements of wind direction and wind speed, Principles of wind measuring instruments (The pressure plate anemometer, The rotation sensor cup – wheel – propeller, Anemometers measuring run of wind).
6. Measurement of precipitation (liquid and solid precipitation), units of measurement, Principles of the Point measurement of precipitation, Non – recording precipitation gauges (daily rain gauges of the unshielded and shielded types), Recording precipitation gauges (siphon, float type, tipping bucket, Weighing balance type), Exposure requirements concerning precipitation point – measurement instruments, Routine care of precipitation measuring instruments, Factors affecting the accuracy of point – precipitation measurements.
7. Measurement of evaporation, General units of measurements, Principles of evaporation measuring Instruments (evaporation pan: Class A Pan, the hooked – gauge type, etc.), General requirements for the evaporation measuring instruments' Exposure, routine care of evaporation – measuring instruments.

8. Sunshine duration measurement, General principles of sunshine duration measurement, The Campbell Stokes sunshine duration recorders, Sitting and exposure requirements for sunshine duration measuring instruments; factors affecting the sunshine records of the Campbell Stokes instrument, Routine care of the Campbell Stokes sunshine recorder, measurement of burnt trace on the cards.
9. Automation of the measurement of Meteorological variables, Technical and economic aspects of automation objectives, Classification of automatic weather stations, Basic block diagram of an automatic weather station, Sensors used with automatic weather stations, Maintenance of automatic weather stations, Reliability of automatic equipment.

LEARNING OUTCOMES FOR SYNOPTIC METEOROLOGY

- To Be Able To Identify Clouds And Their Associated Characteristics And Formation
- To Be Able To Understand The Importance Of The Global Atmosphere And Its Spatio-Temporal Variability
- To Be Able To Identify The Various Synoptic Features Meteorological Charts And Imageries And Their Effects
- To Be Able To Understand Tropical Disturbances And Their Roles In Weather Processes And The ITD
- To Be Able To Understand The Connection Between Tropical And Extra-Tropical Systems
- To Understand The Processes Leading To Cloud Formation And Triggering Processes/ Propagation And Regeneration

- To Be Able To Understand The Concept Of Mesoscale Systems In The Tropics
- To Be Able To Understand And Explain The Concept Of Airmasses And The Modification.
- To Be Able To Identify The Hazardous Weather Situations And Their Socio-Economic Importance To The Area Of Consideration

SYNOPTIC METEOROLOGY (PWS 104)

1. Introduction and Definition of Synoptic Meteorology.
2. ITD and the associated weather zones. Waves and jet streams, land and Sea breeze, anabatic and Katabatic winds. Evolution and Dynamics of west African line squall.
3. Tropical Weather systems. Trade inversions trade winds, Tropical/subtropical jet streams, and other broad wind systems. Rainfall, Tropical cyclones, monsoons. Characteristic patterns of cloud associated with easterly waves, seasonal evolution of the tropical wind systems, and the inter-tropical convergence zone; annual cycles.
4. Mid-latitude synoptic systems. Air-mass concept; source areas; formation processes for air-masses. Air-mass modification; thermodynamic and dynamic changes; boundary/interface between

two adjacent air masses; the slope of steady-state frontal zones; frontal-wave depression.

5. General circulation