# Syllabus of Ph.D.

**Revised Ph.D. Courses for the Department of Agricultural Meteorology and Physics, Faculty of Agriculture, B. C. K. V., Mohanpur.**

## AGM 509 WEATHER FORECASTING FOR AGRICULTURE 2+1

### Objective

To impart theoretical and practical knowledge of forecasting techniques used for weather prediction and preparation of agro-advisories.

### Theory

UNIT I

Weather forecasting system: definition, scope and importance; historical background; observational network of weather forecasting; weather forecasting network in India; benefits of weather forecasting to agriculture; forecasting problems; classified terminology of weather parameters used in weather forecasts and their interpretation; elements of agricultural weather forecasts; types of forecasting: short, medium and long-range; study of synoptic charts with special reference to location of highs and lows, jet streams, synoptic features and weather anomalies and zones of thermal advection and interpretation of satellite pictures of clouds in visible and infra-red range.

UNIT II

Approaches for weather forecasts: methods of weather forecasts - synoptic, numerical prediction, statistical, analogue, persistence and climatological approach, nano-technological approach, Indigenous Technical Knowledge (ITK) base- signals from flora, fauna, insects, birds, animals behavior; various methods of verification of location-specific weather forecast.

UNIT III

Special forecasts: special forecasts for natural calamities such as drought, floods, high winds, cold (frost) and heat waves, hail storms, cyclones and protection measures against such hazards; weather based advisories: concept of agrometeorological advisory; interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production; preparation of weather-based advisories for farmers and dissemination; verification of weather forecasts.

### Practical

- Exercise on weather forecasting for various applications.
- Preparation of weather-based agro-advisories based on weather forecast using various approaches and synoptic charts.
- Preparation of crop-weather calendar for principal crops.
- Preparation of pest -weather calendar for principal insect pests.
- Preparation of disease-weather calendar for principal diaseases.
- Preparation of agrometeorological advisory services (AAS) bulletin for farmers.
- Verification of medium range weather forecasts and analysis of feedback from farmers receiving AAS bulletins.

### Suggested Readings

Alan Watts 2005. *Instant Weather Forecasting*. Water Craft Books.

Lenka, D. 1998. *Climate, weather and Crops in India.* Kalyani Publishers.

Petterssen, S. 1956. *Weather Analysis and Forecasting*. Mcgraw-Hill

Ram Sastry AA. 1984. *Weather and Weather Forecasting*. Publication Division, GOI, New Delhi.
Singh SV, Rathore LS & Trivedi HKN. 1999. *A Guide for Agrometeorological Advisory Services*. Department of Science & Technology, NCMRWF, New Delhi.
Wegman & Depriest 1980. *Statistical Analysis of Weather Modification Experiments*. Amazon Book Co.

**AMP 556 CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT 2+0**

**Objective**

To impart the theoretical knowledge of climate change and their sources.

**Theory**

UNIT I

Climate change and global warming: definitions of terms; causes of climate change and global warming; greenhouse gases, ozone depletion; past records, present trends, extreme weather events and future projections; astronomical predictions: lunar cycle, sunspot cycle, soil-lunar tides, Chandlers compensation, blocking highs; case studies on various climatic projections and consequences thereof in relation to agriculture.

UNIT II

Impacts of climate change on various systems: impacts resulting from projected changes on agriculture and food security; hydrology and water resources; terrestrial and freshwater ecosystems; coastal zones and marine ecosystems; human health; human settlements, energy, and industry; insurance and other financial services; climate change and crop diversification, loss of biodiversity, microbes and pest dynamics; climate change and storage, climate change and weed management; advance methodology of assessing the impact of climate change on crops.

UNIT III

Sensitivity, adaptation and vulnerability: system's sensitivity, adaptive capacity and vulnerability to climate change and extreme weather events; regional scenarios of climate change and variability.

UNIT IV

Mitigation strategies for sustainable development: international policies, protocols, treaties for reduction in greenhouse gases and carbon emissions; carbon sequestration; carbon credit; clean development mechanism (CDM) and land use, land use change and forestry mechanism, alternate energy sources etc.

UNIT V

Agricultural food security: reduction in carbon and GHG emission; fuel conservation and reduction in energy use, conservation tillage, biofuels for fossil fuels, reduction in machinery use etc; increasing carbon sinks; resource conservation technologies, mixed rotations of cover and green manure crops, minimization of summer fallow and no ground cover periods etc.

**Suggested Readings**

Anonymous. *Clean Development Mechanism: Building International Public-Private Partnership under Kyoto Protocol*. UNEP, UNDP Publ.
Anonymous. *IPCC Assessment Reports on Climate Change (2001, 2007)*. WMO, UNEP Publ.
Bishnoi OP. 2007. *Principles of Agricultural Meteorology.* Oxford Book Co.
Jepma CJ & Munasinghe M. 1998. *Climate Change Policy: Facts, Issues and Analysis*. Cambridge Univ. Press.

Mintzer IM. 1992. *Confronting Climate Change: Risks, Implications and Responses.* Cambridge Univ. Press.
Pretty J & Ball A. 2001. *Agricultural Influence on Carbon Emission and Sequestration: A Review of Evidence and the Emerging Trading Options*. Univ. of Essex.
Pretty JN. 1995. *Regenerating Agriculture: Policies and Practices for Sustainable and Self Reliance*. Earthscan.
Salinger J, Sivkumar MVK & Motha RP. 2005. *Increasing Climate Variability of Agriculture and Forestry.* Springer.
Sinha SK. 1998. *Dictionary of Global Climate Change*. Commonwealth Publ.

**AGM 601 HYDROMETEOROLOGY 2+1**

**Objective**

To impart the theoretical and practical knowledge of different components of hydrologic cycle.

**Theory**

UNIT I

Hydrologic cycle and its modification; rainfall and its interception by plants and crops. Interpolation and measurement of missing rainfall data; adequacy of rain gauges; average rainfall on an area depth basis; presentation and processing of precipitation data.

UNIT II

Measurement of runoff, infiltration, moisture retention of soil, percolation, evaporation, evapotranspiration and its importance to agriculturists, irrigation engineers and flood forecasting personnel; water holding capacity of soils, plant available water, cultural practices on soil moisture in relation to different phases of crop growth; evaporation from snow, lakes, reservoirs and crop fields.

UNIT III

Classifying rainfall data into class interval; ranking of rainfall data; relationship between intensity and duration; methods of predicting runoff rate; factors affecting runoff; rainfall-runoff relation; estimation of evapotranspiration from water balance methods; response of crops to water stresses under different agroclimatic situation on India.

UNIT IV

Moisture availability indices and their application for Indian condition; wet and dry spell by Markov-chain model; drought and its classification, hydrological drought, drought indices and their applications under Indian conditions.

**Practical**

- Analysis of rainfall data
- Determination of effective rainfall
- To estimate missing rainfall data for a given station.
- To find out the optimum number of rain gauges for a given catchment.
- To find out the mean rainfall for a given drainage basin by Thiessen polygon method and isohyetal method.
- To estimate the volume of runoff by SCS method.
- Estimation of evopotranspiration from field based water balance method.

**Suggested Readings**

Chow, Ven Te (Ed.). 1964. *Handbook of Applied Hydrology.* McGraw-Hill.
Hillel, D. 1971. *Soil and Water.* Academic Press.
Hillel, D. 1980. *Application of Soil Physics*. Academic Press.

Hillel, D. 1998. *Environmental Soil Physics*. Academic Press.

**AGM 602 MONSOON METEOROLOGY 2+0**

**Objective**

To impart the theoretical knowledge of different aspects of monsoon.

**Theory**

UNIT I

Monsoon and its origin; global pressure distribution; major wind systems and their seasonal variability; monsoon as a global phenomenon; Asiatic monsoon; Indian monsoon and its seasonal aspects: south-west monsoon, north-east monsoon, western disturbances, onset, advancement and retreat of monsoon in different parts of India, regional features, orographic influences; inter annual variability of monsoon; role of Walker and Hadley cell.

UNIT II

El Nino, La Nina, southern oscillation index and their impact on monsoon; synoptic weather systems affecting Indian monsoon and their short and medium range forecasting; tropical cyclone: its genesis and forecasting; monsoon experiments (MONEX) and numerical modeling; long range forecasting of Indian monsoon rainfall, Parametric model, Auto regression integrated moving average (ARIMA) model.

**Suggested Readings**

Das, PK. 1986. *Monsoons.* WMO NO. 613.
Das, PK. 1995. *The Monsoon.* 3rd Edn., National Book Trust.
Pedelaborde, P. 1963. *The Monsoon.* Methuen.
Ramage, CS. 1971. *Monsoon Meteorology.* Academic Press.

**AGM 603 PRINCIPLES OF REMOTE SENSING AND ITS APPLICATIONS IN AGRICULTURE 2+1**

**Objective**

To impart the theoretical and practical knowledge of remote sensing principles and their use to estimate of agro-meteorological variables.

**Theory**

UNIT I

Basic components of remote sensing- signals, sensors and sensing systems; active and passive remote sensing.

UNIT II

Characteristics of electromagnetic radiation and its interaction with matter; spectral features of earth's surface features; remote sensors in visible, infrared and microwave regions.

UNIT III

Imaging and non-imaging systems; framing and scanning systems; resolution of sensors; sensor platforms, their launching and maintenance.

UNIT IV

Data acquisition system, data preprocessing, storage and dissemination; digital image processing and information extraction.

UNIT V

Microwave remote sensing; visual and digital image interpretation; introduction to GIS and GPS.

UNIT VI

Digital techniques for crop discrimination and identification; crop stress detection - soil moisture assessment, inventory of ground water and satellite measurement of surface soil moisture and temperature; drought monitoring, monitoring of crop disease and pest infestation.

UNIT VII

Soil resource inventory; land use/land cover mapping and planning; integrated watershed development; crop yield modeling and crop production forecasting.

UNIT VIII

Estimation of evapotranspiration through satellite imageries – MODIS, TERRA, AQUA, AVHRR, NOVA etc.; modeling for potential ET & reference ET, and ET through remote sensing.

**Practical**

- Acquisition of maps
- Field data collection
- Map and imagery scales
- S/W and H/W requirements and specifications for remote sensing
- Data products, their specifications, media types, data inputs, transformation, display types, image enhancement
- Image classification methods
- Evaluation of classification errors
- Crop discrimination and acreage estimations
- Differentiation of different degraded soils
- Time domain reflectometry
- Use of spectrometer and computation of vegetation indices
- Demonstration of case studies
- Hands on training
- Computation evapotranspiration by remote sensing.

**Suggested Readings**

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Colwell RN. (Ed*.). Manual of Remote Sensing*. Vols. 1, II. Am. Soc. Photogrammetry, Virginia.
Curan PJ. *Principles of Remote Sensing*. ELBS/Longman.
Georg Joseph 2005. *Fundamentals of Remote Sensing*. University Press (India).
Jain AK. 1989. *Fundamentals of Digital Image Processing*, Prentice Hall of India.
Narayan LRA. 1999. *Remote Sensing and its Applications*. Oscar Publ.
Patel AN & Surender Singh 2004. *Remote Sensing: Principles and Applications*. Scientific Publ.

**AGM 605 AGROMETEOROLOGICAL ASPECTS OF EVAPOTRANSPIRATION 2+0**

**Objective**

To impart the theoretical knowledge of evapotranspiration estimation and measurement.

**Theory**

UNIT I

Theories of evaporation and evapotranspiration: aerodynamic energy balance and Combined approaches; application of evapotranspiration theories; concept of potential, reference and actual evapotranspiration; impact of microclimate, crop and soil on status of evapotranspiration; modification of evapotranspiration rate through management practices; techniques of lysimetry in measuring actual evapotranspiration; crop coefficient and its significance in computation of evapotranspiration demand.

UNIT II

Yield functions, water use efficiency and scheduling of irrigation based on evapotranspiration; infrared thermometry in relation to evapotranspiration status of crop field; simulation of evapotranspiration by using empirical and mechanistic models; evapotranspiration and growth relation; regional scale crop planning on the basis of soil water balance.

**Suggested readings**

Doorenbos , J. and Pruitt, WO. 1975. *Crop Water Requirements.* FAO.
Hillel, D. 1971. *Soil and Water.* Academic Press.
Hillel, D. 1980. *Application of Soil Physics.* Academic Press.
Hillel, D. 1998. *Environmental Soil Physics*. Academic Press.
Lenka, D. 1998. *Climate, weather and Crops in India.* Kalyani Publishers.

**AGM 606 METEOROLOGICAL ASPECTS OF AGRICULTURAL DROUGHT 1+1**

**Objective**

To impart theoretical and practical knowledge of different aspects drought and their effect on agriculture.

**Theory**

UNIT I

Introduction; definition of drought: based on rainfall, temperature, soil water, crop parameter, climate, indices and ET estimates; meteorological indices of agricultural drought; methods of drought analysis: statistical analysis of rainfall and water balance approach; the plant agricultural practices and drought; types of drought and their causes; local environmental control of drought: modification of wind, radiation, rain, evaporation and soil moisture.

UNIT II

Types of agricultural drought in India; contingent crop planning for drought management; need for a world climate watch on drought; prediction of drought: crop stress detection, crop water stress index; air pollution stress and its influence on vegetation.

**Practical**

- Frequency distribution of dry spell of different length.
- Estimation of deciles of rainfall.
- Different soil water balance techniques for drought estimation.
- Estimation of Palmer drought indices.
- Development of index of drought proneness through Markov chain model.
- Estimation of agricultural drought by different approaches.
- Estimation of atmospheric drought by different approaches.

**Suggested Readings**

Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
Chritchfield HJ. 1994. *General Climatology*. Prentice Hall.
Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.
Samra JS, Pratap Narain, Rattan RK & Singh SK. 2006. *Drought Management in India*. Bull. Indian Society of Soil Science 24, ISSS, New Delhi.
WMO. 1975. *Drought and Agriculture.* Technical Note No. 138, WMO NO. 392, WMO, Switzerland.

**AGM 604 ENVIRONMENTAL PHYSICS FOR AGRICULTURAL METEOROLOGY 3+0**

**Objective**

To impart theoretical knowledge of physical processes applied in agricultural meteorology.

**Theory**

UNIT I

Thermodynamics of the atmosphere. Physics of radiation: origin and nature of radiation, radiation geometry in Cartesian, spherical cylindrical coordinate systems, conservation principles for radiant energy; fluid motion: laminar and turbulent transfer, fluctuation theory for turbulent transfer of momentum, heat and water vapour.

UNIT II

Physics of evaporation: aerodynamic approach, energy balance approach and combination approach for evaporation estimates.

UNIT III

Physics of soil water system: the concept of potential as applied to soil water system, total potential and components, movements of water on soil, fundamental equation, hydraulic conductivity, infiltration, field drainage and water vapour movement in soil.

UNIT IV

Physics of water use: a physical introduction to plant-water system and relationships, water transport through soil-plant-atmosphere systems, measurement of crop water use in terms of water conservation equation.

**Suggested readings**

Hillel, D. 1971. *Soil and Water.* Academic Press.
Hillel, D. 1980. *Application of Soil Physics*. Academic Press.
Hillel, D. 1998. *Environmental Soil Physics*. Academic Press.
Monteith, JL .1973. *Principles of Environmental Physics.* Edward Arnold.
Rose, CW. 1966. *Agricultural Physics.* Pergamon Press.
Sellers, WD. 1965. *Physical Climatology.* University of Chicago Press.
Van Wizk, WR. 1963. *Physics of Plant Environment.* North-Holland Publishing.
Waggoner, PE. (Ed.). 1965. *Agricultural Meteorology.* American Meteorological Society.

**AMP 799 SEMINAR-I 0+1 1st Semester**

**AMP 899 SEMINAR-II 0+1 4th Semester**

**AMP 999 SEMINAR-III 0+1 6th Semester**

**DOCTORAL RESEARCH 45**