



Mahatma Phule Krishi Vidyapeeth Rahuri-413 722, Dist. Ahmednagar (MS)

Doctoral Programme *in* Agricultural Meteorology

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	15
2.	Minor	08
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	75
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min. 15 credits)			
1.	AGM 601	Climate Change and Sustainable Development	2+1
2.	AGM 602	Weather Forecasting	2+1
3.	AGM 603	Air Pollution Meteorology	2+1
4.	AGM 605	Analytical Tools and Methods for Agro-meteorology	2+1
5.	AGM 606	Strategic Use of Climatic Information	2+1
6.	AGM 609	Advanced Micrometeorology	3+0
7.	AGM 610	Advanced Climatology	2+1
8.	AGM 611	Agro-meteorology for Multiple Cropping Systems	2+1
9.	AGM 691	Doctoral Seminar I	1+0
10.	AGM 692	Doctoral Seminar II	1+0
11.	AGM 699	Doctoral Research	45

B) Minor Subjects (Min. 08 credits)			
1.	AGM 604	Weather, Climate and Livestock	2+1
2.	AGM 608	Database Management and Commercialization of Agro-meteorological Data In E-Services	1+2
3.	AGM 607*	Mathematics in Agriculture and Biology	2+1
4.	AGM612	Advanced Aerobiometeorology	2+1
*This course is not offered by the Department of Agril. Meteorology College of Agriculture, Pune			
C) Supporting Subjects (Min. 05 credits)			
1.	AGM 603	Air Pollution Meteorology	2+1=3
2.	AGM 611	Agro-meteorology for Multiple Cropping Systems	2+1=3
D) Seminar (02 credit)			
1.	AGM 691	Doctoral Seminar (Major)	1+0=1
2.	AGM 692	Doctoral Seminar(Minor)	1+0=1
E) Doctoral Research (45 credits)			
1.	AGM 699	Doctoral Research	45
F) Non Credit Compulsory Courses(06 credits)			
1	PGS 501	Library and Information Services	0+1=1
2	PGS 502	Technical Writing and Communication Skills	0+1=1
3	PGS 503	Intellectual Property and its Management in Agriculture	1+0=1
4	PGS 504	Basic Concepts in Laboratory Techniques	0+1=1
5	PGS 505	Agricultural Research Ethics and Rural Development Programme	1+0=1
6	PGS 506	Disaster Management	1+0=1

Course Contents

A) Major Subjects:

AGM 601: CLIMATE CHANGE AND SUSTAINABLE DEVELOPMENT 2+1

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.

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.

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.

Practical:

- Case studies on various climatic projections and consequences thereof in relation to agriculture
- Advance methodology of assessing the impact of climate change on crops

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 S. K. 1998. Dictionary of Global Climate Change. Commonwealth Publ.

AGM 602: WEATHER FORECASTING 2+1

Theory:

UNIT I

Weather forecasting system: definition, scope and importance; 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; weather forecasting network.

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

Weather based advisories: interpretation of weather forecasts for soil moisture, farm operations, pest and disease development and epidemics, crops and livestock production; preparation of weather-based advisories and dissemination.

UNIT IV

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.

UNIT V

Modification of weather hazards: weather modification for agriculture; scientific advances in artificial rain making, hail suppression, dissipation of fog and stratus clouds, modification of severe storms and electric behavior of clouds.

Practical:

- Exercise on weather forecasting for various applications
- Preparation of weather-based agro-advisories based on weather forecast using various approaches and synoptic charts.

Suggested Readings:

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

AGM 603: AIR POLLUTION METEOROLOGY 2+1

Theory:

UNIT I

Introduction to air pollution- history, definition: clean air definition; natural versus polluted atmosphere; atmosphere before the industrial revolution. UNIT II Sources of air pollution; classification and properties of air pollutants; emission sources, importance of anthropogenic sources; behaviour and fate of air pollutants; photochemical smog; pollutants and trace gases.

UNIT III

Meteorological factors in the dispersion of air pollutants; topographical, geographical and large scale meteorological factors attached air pollution; meteorological conditions and typical plume forms; air pollution forecasting – Gaussian diffusion models, Numerical dispersion models.

UNIT IV

Air quality standards; effect of air pollution on biological organisms; ozone layer depletion; air pollution control technologies; management of air pollution; principles of diffusion of particulate matter in the atmosphere; air pollution laws and standards.

UNIT V

Air pollution sampling and measurement: types of pollutant sampling and measurement, ambient air sampling, collection of gaseous air pollutants, collection of particulate pollutants, stock sampling; analysis of air pollutants - sulfur dioxide, nitrogen dioxide, carbon monoxide, oxidants and ozone, hydrocarbons, particulate matter.

UNIT VI

Scales of air pollution: local, urban, regional, continental and global.

Practical:

- Measurement of different air pollutants
- Measurement of different air pollution gases
- Measurement of visibility
- Measurement of ozone and aerosol optical thickness (AOT)
- To study the temperature profile at different heights
- To study the stability of the atmosphere
- To determine height of partial flume through chimani
- To study the effect of temperature on vegetables, orchards and agricultural crops

Suggested Readings:

- Arya SP. 1998. Air Pollution Meteorology and Dispersion. Oxford Univ. Press.
- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- Chhatwa GR. 1989. Environmental Air Pollution and its Control. Anmol Publ.
- Mishra PC. 1990. Fundamentals of Air and Water Pollution. Ashish Publ.
- Mudd J Brian & Kozlowski TT. (Ed.). 1975. Responses of Plants to Air Pollution. Academic Press.
- Pickett EE. 1987. Atmospheric Pollution. Hemisphere Publ. Corp.
- Sharma SH & Khan TI. 2004. Ozone Depletion and Environmental Impacts. Pointer Publ.

- Weber E. 1982. Air Pollution Assessment Methodology and Modeling. Plenum Press.
- Yunus M & Iqbal M. (Eds.). 1996. Plant Response to Air Pollution. John Wiley & Sons.

AGM 605: ANALYTICAL TOOLS AND METHODS FOR AGRO-METEOROLOGY 2+1

Theory

UNIT I

Review of agro-climatic methods; characterization of agroclimatic elements; sampling of atmosphere; temporal and spatial considerations; micro-meso-macro climates.

UNIT II

Network spacing; spatial and temporal methods; GIS fundamentals and applications; numerical characterization of climatic features; crop response to climate, time lags, time and distance constants, hysteresis effects.

UNIT III

Influence of climate on stress-response relations; thermal time approach in agroclimatology- heat and radiation use efficiency in crop plants; applications to insect-pest development and prediction; comfort indices for human and animals; impact of natural and induced variability and change of climate on crop production.

UNIT IV

Instrumentation and sampling problems; design of agro-meteorological experiments.

UNIT V

Basic knowledge of application of computers in agriculture; theories of computer language BASIC, FORTRAN, C, C++ and Visual basic.

UNIT VI

Empirical and statistical crop weather models and their application with examples; incorporating weather, soil, plants and other environment- related parameters as subroutine and remote sensing inputs in models; growth and yield prediction models; crop simulation models; forecasting models for insects and diseases.

Practical:

- Calculation of continentality factors.
- Climatic indices and climogram.
- Agrometeorological indices: Degree-days, photothermal units, heliothermal units, phenothermal index.
- Heat and radiation use efficiency and other indices of crops.
- Crop growth rates.
- Analysis of thermogram, hygrogram, hyetogram, sunshine cards etc. stream lines and wind roses and statistical analysis of climatic data.
- Working with statistical models: crop yield forecasting, crop weather relationship and insect & disease forecasting models.
- Working with crop simulation models
- Small programme writing in computer languages like BASIC, FORTRAN, C, C++ and Visual basic.
- Geographical Information System.

Suggested Readings:

- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- Cooper M. 2006. The Spirit of C. An Introduction to Modern Programming. Jaico Publ.
- Malczewski J. 1999. GIS & Multicriteria Decision Analysis. John Wiley & Sons.

AGM 606: STRATEGIC USE OF CLIMATIC INFORMATION 2+1**Theory:****UNIT I**

Increasing awareness on potential climate hazards and mitigations: history of climate-related disasters (hazards and vulnerabilities) suffered in the concerned continent/region/country/sub-region and their documented or remembered impacts; hazards and their relation to agricultural production risks (intra- and inter-annual); efforts made in mitigating impacts of (future) disasters (prevention); trends discernable in occurrence and character of disasters, if any.

UNIT II

Selection of appropriate land use and cropping patterns: types and drivers of agricultural land use and cropping patterns; history of present land use and cropping patterns in the continent/region/country/sub-region concerned as related to environmental issues; successes and difficulties experienced by farmers with present land use and cropping patterns; outlook for present land use and cropping patterns and possible alternatives from an environmental point of view.

UNIT III

Recent trends in land use and cropping patterns; adoption of preparedness strategies - priority settings for preparedness strategies in agricultural production; preparedness for meteorological disasters in development planning; permanent adaptation strategies that reduce the vulnerabilities to hazards; preparedness as a coping strategy.

UNIT IV

Making more efficient use of agricultural inputs: agro-meteorological aspects of agricultural production inputs and their history; determination of input efficiencies; other factors determining inputs and input efficiency; actual use of inputs in main land use and cropping patterns of the region.

UNIT V

Selection of livestock management: history of livestock management patterns in the continent/region/country/sub-region concerned as related to environmental issues; successes and difficulties experienced by farmers with present livestock management strategies; outlook for present livestock management strategies and possible alternatives from an environmental point of view; recent trends in livestock management strategies.

UNIT VI

Adoption of microclimate modification techniques: review of microclimate management and manipulation methods; history of microclimate modification techniques practised in the continent/country/sub-region concerned; possible improvements in adoption of microclimate modification techniques, given increasing climate variability and climate change; local trends in adoption of such techniques.

UNIT VII

Protection measures against extreme climate: history of protection measures against extreme climate in the continent/region/country/sub-region concerned;

successes and difficulties experienced by farmers with present protection measures; outlook for present protection measures and possible alternatives; trends in protection methods against extreme climate.

Practical:

- Outlook for present land use and cropping patterns and possible alternatives from environmental point of view
- Recent trends in land use and cropping patterns
- Agro-meteorological services to increase farmers design abilities of land use and cropping patterns
- Systematic and standardized data collection on protection measures against extreme climate

Suggested Readings:

- Anonymous. Clean Development Mechanism: Building International Public-Private Partnership under Kyoto Protocol. UNEP, UNDP Publ.
- Anonymous. IPCC Assessment Reports on Climate Change Policy: Facts, Issues and Analysis. Cambridge Univ. Press.
- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- 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.
- Sinha SK. 1998. Dictionary of Global Climate Change. Commonwealth Publ.

B) Minor Subjects:

AGM 604: WEATHER, CLIMATE AND LIVESTOCK 2+1

Theory:

UNIT I

Thermal balance in animals; energy exchange processes at the skin of the animals and the need for the maintenance of thermal balance in the animals. UNIT II Effects of weather on animal production, loss of water from the body, growth rate and body weight, reproduction, grazing habit, food intake, milk production, sun burns and photosensitive disorders.

UNIT III

Meteorological conditions prevailing in glass-house, green house, animal shed, poultry house and grain storage barns; heating, cooling and ventilation of these structures as governed by meteorological factors.

UNIT IV

Weather and animal diseases and parasites; diseases of poultry and its relation with weather and thermal comfort.

UNIT V

Management of livestock to reduce greenhouse gas emission.

Practical:

- Measurement of temperature, humidity, net radiation
- Calculation of animal comfort zone index
- Radiation of animal farm house and body
- Estimation of energy fluxes on body
- Measurements of CO₂ and methane in animal farm house

Suggested Readings:

- Kaiser HM & Drennen TE. (Eds). 1993. Agricultural Dimensions of Global Climate Change. St. Lucie Press, Florida.
- Monteith L & Unsworth M. 2007. Principles of Environmental Physics. 2nd Ed. Academic Press.
- Takahashi J, Young BA, Soliva CR & Kreuzer M. 2002. Greenhouse Gases and Animal Agriculture. Proc. 1st International Conference on Greenhouse Gases and Animal Agriculture.
- Tromp SW. 1980. Biometeorology. The Impact of the Weather and Climate on Humans & their Environment. (Animals & Plants). Heyden & Son Ltd.

AGM 607: MATHEMATICS IN AGRICULTURE AND BIOLOGY 2+1**Theory****UNIT I**

Functions: function of a single real variable; single-valued and many-valued functions; linear functions; power functions; polynomial functions; trigonometric, exponential and logarithmic functions; functions of several real variables.

UNIT II

Differentiation: derivative of the function of a single variable; derivatives of the functions of several variables-partial derivatives; maxima and minima; applications.

UNIT III

Integration: integrals of functions with respect to their independent variables; indefinite, definite and infinite integrals, applications.

UNIT IV

Ordinary differential equations: classification; solution of linear differential equations; applications; partial differential equations - classification, applications.

UNIT V

Vectors: rules of the game with the vectors; applications; matrices and determinants: characterization; rules of the game with matrices and determinants; systems of linear algebraic equations and their solutions; characteristic roots of matrices; applications.

UNIT VI

Methods of analysis: averaging and scaling methods, numerical analysis; finite element method, Monte Carlo analysis, spatial variability, stochastic methods, Fourier Analysis, perturbation; iterative and optimal techniques; applications.

UNIT VII

Probability: probability and probability distributions; applications.

Practical:

- Use of simple log and semi-log graph papers
- Use of logarithms and logarithmic tables
- Plotting linear and log graph

- Trigonometric functions and relations
- Data representation as pie, bar and histograms
- Statistical data analysis-averages, standard deviations, simple correlation coefficient

Suggested Readings:

- Arya JC & Lardner RW.1979. Mathematics for Biological Sciences. Prentice Hall.
- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- Crank J, Martin HG & Melluish DM. 1980. Mathematics for Biological Sciences, Oxford Univ. Press.
- Eason G, Coles C, Wand Gettinby G. 1980. Mathematics and Statistics for Biosciences, Ellis Harwood Ltd.
- Francis 1983. Theory and Problems of Numerical Analysis. McGraw Hill. Hann CT. 1995. Statistical Methods in Hydrology. East-West Press.
- Panse VG & Sukhatme PV. 1983. Statistical Methods for Agricultural Workers. ICAR.
- Ramachery SKVS, Bhujanga Rao M & Bhandari S. 2000. Engineering Mathematics. IBS Publ.
- Ray M & Sharma HS. 1970. Mathematical Statistics. Ram Prasad & Sons. Vashistha AR. 1991. Modern Algebra. Krishna Prakashan Mandir.

AGM 612: ADVANCED AEROBIOMETEOROLOGY

2+1

Objective:

To impart the theoretical and practical knowledge of aerobiometeorological parameters and their applications in the agriculture. Advanced information in Definitions and structure of aerobiometeorology, Role of aerobiometeorology and biogeography inforecasting pests and diseases outbreak, Overall approach to insect problems in agriculture, Insect movement in the atmosphere, Effect of temperature, humidity, wind and rain as the dispersal, Immigrates and emigraties of pest and pathogens, Management of plant pathogens, Modification of plant canopy and its impact on plant diseases, Role of aerobiometeorology in integrated pest and diseases management programme. Effect of sudden weather changes on the population built up of pest and diseases, Swarma of locusts and other insects in relation to weather, Air pollution and Plant injury, acid rains.

AGM 608: DATABASE MANAGEMENT AND COMMERCIALIZATION OF AGROMETEOROLOGICAL DATA IN E-SERVICES 1+2

Theory

UNIT I

Data and information; types of data; climate, soil and crop data; Importance of database management; data requirements; data collection and recording (Automatic and manual).

UNIT II

Data structure/format; quality control of data; techniques of climatic data generation; missing data; introduction to different software for database management.

UNIT III

Processing and analysis of data and data products; value addition of data and data products; data users, public, commercial, academic or research. UNIT IV

Availability, accessibility and security of data; evaluating the cost of data; e-management of data.

Practical:

- Types of instruments and data recording
- AWS data retrieval, storage and transfer
- Exposure to different software for Agromet data analysis; exposure to Statistical software
- Temporal and spatial analysis of data; exposure to GIS
- Value addition to data
- Introduction to internet protocols
- Uploading and downloading data, password and security of data
- E-management of data

Suggested Readings:

- Ghadekar R. 2002. Practical Meteorology – Data Acquisition Techniques, Instruments and Methods. 4th Ed. Agromet Publ.
- IMD/ WHO. 1988. Users Requirements for Agrometeorological Services. IMD.
- Miles MB & Huberman AM. 1994. Qualitative Data Analysis. Sage Publ.
- Panse VG & Sukhatme PV. 1983. Statistical Methods for Agricultural Workers, ICAR.
- Potter GB. 1994. Data Processing: An Introduction. Business Publ.
- Ramakrishnan R. & Gehrke J. 2003. Database Management System. McGraw-Hill.

AGM 609: ADVANCED MICROMETEOROLOGY 3+0=3

Theory:

- Introduction and review of Physical laws,
- Turbulance mechnism,
- Dynamics of turbulance,
- Semi-empirical theories of turbulance,
- Turbulance structure-experimental obsrvations,
- Turbulance, Instrumentations and data logging-Applications

Practical:

- Micrometerological measurements in crop canopies
- Quantification of crop microclimate
- Determination of ET and its computation by different methods

Suggested Readings:

- Arya S Pal. 1988. Introduction to Micrometeorology. Academic Press.
- Bishnoi OP. 2007. Principles of Agricultural Meteorology. Oxford Book Co.
- Gates DM. 1968. Energy Exchange in the Biosphere. UNESCO.
- Goudriaan J. 1983. Crop Micrometeorology: A Simulation Study. Scientific Publ.

- Grace J. 1983. *Plant Atmospheric Relationships: Outline Studies in Ecology*. Chapman & Hall. 172
- Gupta PL & Rao VUM. 2000. *Practical Manual on Micrometeorology*. Dept. of Agril. Meteorology, CCS HAU Hisar, India.
- Jones HG. 1992. *Plants and Microclimate*. Cambridge Univ. Press.
- Munn RE. 1970. *Biometeorological Methods*. Academic Press.
- Rosenberg NJ. 1974. *Microclimate – The biological Environmet*. John Wiley & Sons.
- Sellers W. 1967. *Physical Climatology*. The University of Chicago Press.

AGM 610: ADVANCED CLIMATOLOGY

2+1 =3

Theory:

- Global Climate,
- Organisation of Climatological activities,
- General Circulation of the atmosphere,
- Climaic Variations,
- Classifications of climates,
- Regional climates as relateed to the dynamics of the atmosphere,
- Forecasting and Farm Advisories

Practical:

- Preparation of climatic water budget
- Estimation of agro-meteorological variables using historical records
- Degree day concept and phenology forecasting and preparation of crop calendar
- Evaluation of radiation, wind and shading effects in site selection and orientation
- Study of weather-pest and disease interactions, calculation of continentality factors; calculation of comfort indices and preparation of climograph.

Suggested Readings:

- Barry RG & Richard JC. 2003. *Atmosphere, Weather and Climate*. Tailor & Fransics Group. 170
- Bishnoi OP. 2007. *Principles of Agricultural Meteorology*. Oxford Book Co.
- Ghadekar SR. 2001. *Meteorology*. Agromet Publ.
- Mcllveen R. 1992. *Fundamentals of Weather and Climate*. Chapman & Hall.
- Petterson S. 1958. *Introduction to Meteorology*. McGraw Hill.
- Trewartha Glenn T. 1954. *An Introduction to Climate*. McGraw Hill.

AGM 611: AGROMETEOROLOGY FOR MULTIPLE CROPING SYSTEMS

2+1 =3

Theory:

- Multiple cropping: sequential cropping, mixed cropping, row (inter) cropping, strip (inter) cropping, relay (inter) cropping
- Agroforestry and their meteorological and climatological aspects with emphasis on low external input dry farming multiple cropping "cropping & farming" systems
- Biomass management aspects of the above, limiting factors & competition in multiple cropping; Purely sequential systems in the same crop space or part of its; Spatial and temporal intercropping without "active" services rendered "Active" services rendered "Active" services from one intercrop to its companion crop (s) micrometeorological and/ or other environmental advantages; Domination in space and time in high intimacy multiple cropping systems; home-garden agroforestry and their micrometeorological aspects, other aspects of agroforestry and Meteorology.