

**Syllabus**  
**for the**  
**Ph. D course work**  
**in**  
**Atmospheric Sciences**

**(Approved by the Board of Studies in Atmospheric Science held on 30.04.2015)**

# Paper I

## Research methodology

### Research Methods:

Research Formulation: Selection of the problem and its necessity, Literature review-reviews, treatise, monographs, web as a source, identifying gap areas, development of working hypothesis, Data collection and analysis: Methods of data collection: observation and modeling, sampling methods

Methods of writing Thesis, Document writing in Word and LaTeX

Techniques for oral and poster presentations - preparation of the presentation- Layout, structure and language, bibliography, referencing and footnotes.

Ethics in publishing- copyright, reproduction of published materials, plagiarism, citation and acknowledgement.

### Progammig and Statistical analysis:

Scientific programming: Introduction to FORTRAN and MATLAB.

Statistical analysis: Data interpretation and analysis, precision and accuracy, Poisson and Gaussian distribution- Mean, Median, Mode, Standard deviation and Standard error- Systematic and random errors- Propagation of errors -Moving average, Goodness of fit, least squares fitting, linear and nonlinear curve fitting, Degrees of freedom- Significance of correlation,  $\chi^2$  test, Student-T test, Correlation analysis- Partial Correlation analysis-Regression analysis-Linear regression- Logarithmic regression-Auto correlation and cross correlation- Multiple regression- Partial differential- Partial derivatives- Numerical differentiation and integration- Time series analysis- Spectral analysis- Fourier and wavelet analysis, Optimization, regularization, minimization of errors.

### Recommended Books:

1. Research Methodology: Methods and Techniques, Kotari, C.R
2. Data reduction and error analysis for the physical sciences, Philip R. Bevington
3. FORTRAN 77 with Application to science and Engineering, Jain, R.P. Suri
4. Scientific papers and Presentations, Martha Davis
5. MATLAB and its applications in Engineering, Raj Kumar Bansal
6. Numerical recipes in fortran 90, Williams H Press et al. 1999
7. Introduction to Numerical Analysis, F B Hildebrand, Tata McGrow Hill, 1979

## **Paper II**

### **Atmospheric Sciences**

**Earth's Atmosphere - origin and composition:** History and evolution of the earth's atmosphere, Atmospheric Composition, Hydrostatic equation, Layers of the atmosphere, variation of pressure with height, Scale height.

**Heat and thermodynamics of the earth's atmosphere:** Black body radiation, Planck's law, Wein's displacement law, Kirchoff's law, Stefan Boltzmann Law, Absorption of radiation by gases, Atmospheric window, Energy balance for the earth atmosphere, Greenhouse effect, Radiative transfer, Heating rate due to radiative processes, scattering of solar radiation: Rayleigh and Mie Scattering

Boundary layer: definition, evolution, depth and structure, vertical structure, significance, Turbulent transport, Taylor's hypothesis, Virtual potential temperature, Significance of turbulence and its spectrum.

Hydrostatic equilibrium-geopotential, hydrodynamic stability- parcel method-Saturated and unsaturated air parcels, saturated adiabatic lapse rate, atmospheric stability, Enthalpy, Water vapour in air and moisture parameters, Dew point, Frost point, conditional and convective instability, Latent heat, Clausius-Claperyon equation

**Dynamics of the earth's atmosphere:** Dynamical equations and conservation laws; Pressure gradient force, Coriolis force, geostrophic approximation, 3-cell circulation of the atmosphere, Walker circulation. Waves and oscillations in the earth's atmosphere, Quasi-biennial oscillation, Madden Julian oscillation, El Nino/La Nina southern oscillations, gravity and planetary waves, Dynamical coupling of the atmosphere

#### **Minor constituents of the earth's atmosphere:**

Aerosols: Characteristics, spatio-temporal variation, vertical distribution, dynamics of aerosols, aerosol radiative forcing-Direct, indirect and semi-direct effects, climatic impacts.

Trace gases - O<sub>3</sub>, NO<sub>x</sub>, CO, SO<sub>2</sub>, CH<sub>4</sub>, etc, atmospheric chemistry and climatic impacts, air pollution

#### **Clouds:**

Clouds: mechanism of formation and seeding, types, convective clouds/thunderstorms, cloud radiative

properties and latent heat, cloud dynamics.

**Physics of the Ionosphere:** Ionospheric layers, mechanism of production and loss, Chapman profile, Ionospheric conductivity and currents, ionospheric propagation: radio wave in and ionized medium, Appleton-Hartree equation, radio propagation through an irregular plasma, diffraction, Fresnel zone effect, F-region drifts, ion-drag effects, Scintillation, high latitude irregularities- blobs, enhancements, or patches, geomagnetic field and perturbations, Ionospheric Dynamo, Photoionization and planetary ionosphere, equatorial electrojet, Polar ionosphere, space weather events.

**Sun-Earth Interaction:** Structure of the Sun, radiation spectrum, solar wind, interplanetary magnetic field, frozen in fields, solar wind interaction with the magnetosphere, geomagnetic storms, sunspots, solar cycle, solar flares, CME, Sun-Earth Astronomical relationship.

**Atmospheric Measurement Techniques:** Meteorological sensors: AWS, radiosonde; Satellite remote sensing techniques for measurement of clouds, aerosols, radiation: lidar, radar and radiometers, Trace gas analyzers, Optical detectors and characteristics, Mass spectrometry, Langmuir probe, Ionosonde, GNSS, modeling-low latitude Ionospheric model, Atmospheric Chemistry Transport model

#### **Recommended Books**

1. The Atmosphere: An Introduction to Meteorology, F K Lutgens and E J Tarbuck, Prentice Hall
2. Meteorology for Scientists and Engineers, R Stull, Brooks/Cole, Thomson Learning
3. Atmospheric Chemistry and Physics, J H Seinfeld and S N Pandis, John Wiley and Sons
4. Introduction to Atmospheric Physics, D G Andrews, Cambridge University Press
5. Fundamentals of Atmospheric Modelling, M Z Jacobson, Cambridge University Press
6. Introduction to Dynamic Meteorology, J. R. Holton, Academic Press, USA
7. Introduction to Theoretical Meteorology, S. Hess, Holt Publisher, New York
8. Atmospheric Science – An Introductory Survey, J. M. Wallace and P.V. Hobbs, Academic Press
9. The Physics of Atmosphere, John Houghton, Cambridge University Press
10. Fundamentals of Remote Sensing, George Joseph, University Press
11. Introduction to Ionosphere and Magnetosphere, J.S. Retchiffe, Cup Archive, 1972
12. An introduction to Atmospheric Radiation, K.N. Liou, Academic Press, USA
13. The Earth's Atmosphere: Its Physics and Dynamics, Kshudiram Saha
14. Numerical Weather and Prediction, T T Warner, Cambridge University Press, 2011