Savitribai Phule Pune University
(Formerly University of Pune)

Syllabus for Ph.D. (PET) Entrance Exam : Atmospheric & Space Science

Research Methodology

Research design: Research Question - Null hypothesis & Hypothesis Testing - Logic & importance. Experimental design concept of dependent and independent variable. Concept of measurement, generalization, replication. Merging the two approaches.

Measurement, data collection and analysis: Observation and Collection of data - Methods of data collection, Generalization and Interpretation. Problems in measurement in research - Quality control.

Sampling: Concept of Statistical population, Sample, Sampling Frame, Sampling Error, Sample size. Characteristics of a good sample. Probability Sample - Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample - Practical considerations in sampling and sample size.

Statistical methods in research: Probability and statistics: theory of probability and probability distribution, binomial distribution. Poisson and Gaussian distribution, data preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis.

Measures of central tendency and dispersion, moments, scatter diagram, least squares method. Regression equation, coefficients of correlation by Rank Correlation as well as Product Moment method and their significance, tests of significance, Students'- t, Chi square tests, ANOVA.

Mathematical methods in research
Vectors, Vector differentiation and Vector integration, and its applications, Conservative fields, irrotational, solenoidal vectors. Matrices, Types of matrices including complex matrices, Statement of Caley hamilton's theorem, Methods of finding inverse of matrices, Ordinary Differential equation, degree and order of differential equation. Methods of solving ordinary differential equation numerically. Numerical Integration schemes, Fourier series, Fourier Transform. Classification of Partial differential equations. Finite Difference schemes, Forward,backward and central difference scheme.

Computer programming for data analysis

FORTRAN fundamentals: integer constant, floating point constant, variables, arithmetic operator, relational operator, FORTRAN arithmetic and expression, input/output and format statements, declaration and initialization, branching and looping, Arithmetic IF, Logical IF, Unconditional GO TO, Computed GO TO, DO statement, Nesting of DO Loops, Dimension Statement, arrays, multi-dimensional arrays, functions, sub-programs and subroutines.

Books Recommended

- Introductory methods in Numerical Analysis by S. S. Sastry
- Statistical Methods in Atmospheric Science by Daniel Wilks
- Applied Mathematics for Engineers and Physicists by L. A. Pipes and L. R. Harvill
- Some applications of statistics to meteorology by H.A. Panofsky
- Statistical analysis in climate research by Van Storch & Zwiers
- An introduction to Research Methodology, by Garg, B. L., Karadia, R., Agarwal, F. and Agarwal, U. K.
- Research Methodology: Methods and Techniques. Kothati , C.R., 1990.
- Computer programming in Fortran 90 and 95 by V. Rajaram
- Vector Analysis Schaum Series
- Matrices Schaum Series
- Statistics Schaum Series

Subject Concerned Syllabus
Atmospheric & Space Sciences

Structure and composition of Atmosphere, Synoptic observations, Distribution and variation of: temperature, pressure, relative humidity and winds. Hadley circulation, Trade winds, Inter Tropical Convergence Zone. Synoptic systems in different seasons: Western disturbance, Rossby Waves, Westerly Jet Stream. Fog, Cold Wave. Thunderstorms, Dust storms, Heat wave, Norwesters, Cyclonic disturbances. Fronts and Extratropical systems. Southwest Monsoon: Onset, Active, Withdrawal, Breaks, Depressions, Mid-tropospheric cyclone, Heat lows, Tibetian High, Low Level Jet. Cyclones: Criteria for formation, structure, occurrence over Indian seas North East Monsoon, Rainfall distribution in Northeast Monsoon.

Laws of thermodynamics, Equation of state for dry and moist air, Adiabatic and Isothermal Processes, Humidity Parameters, Virtual Temperature, Standard Atmosphere, Entropy, Potential Temperature, Pseudo-adiabatic Process, Equivalent Temperature, Equivalent Potential Temperature, Claussius–Clapeyron Equation, Static stability, Parcel Method, Cloud entrainment, Application of Hydrostatic equation, Thermodynamic Diagrams. CAPE, CINE and their significance. Types of Clouds, Mechanisms of formation, Nucleation and growth of cloud droplets, Bergeron-Findeisen process.

Fair weather atmospheric electricity: Ions, Conductivity, Electric Field, Currents, Global Electric Circuit, Lightning discharges.

Black body radiation and Laws of radiation, long-wave and short-wave radiation, Atmospheric absorption of Solar Radiation, Emission and Absorption of Terrestrial Radiation, Raleigh and Mie scattering, Absorption spectra of atmospheric gases, Radiative Transfer in the Atmosphere. Effects of green house gases.

Scales of atmospheric motion, Equations of motion in absolute and rotating frame, Tangential and local coordinate system, Coriolis force, Scale Analysis, Rossby number, Natural Co-ordinate System, Trajectory and Stream lines, Blatons Equation, balanced flow-

Geostrophic Flow, Inertial Flow, Cyclostrophic Flow and Gradient Flow. Equations of continuity in cartesian and isobaric co-ordinates. Thermodynamic energy equation, Pressure as vertical co-ordinate and Basic equations in Isobaric Coordinates. Generalized vertical co-ordinates. Differential Properties of wind Fields Translation, Divergence, Rotation and Deformation., Thermal Wind , veering and backing, Kinematics of Pressure Fields: Intensification and Weakening, Deepening and Filling. Vorticity and Circulation. Planetary boundary layer: basic features, structure and evolution, Basic concepts of numerical weather prediction, Premitive equation model, computational instability, CFL conditions. Concept of parameterization and data assimilation.

Kepler's laws, Polar orbiting and Geostationary satellites. Period of a Satellite, Temporal and spatial resolutions.

Ozone hole, geographical distribution of atmospheric aerosols, effects of aerosols on atmospheric radiation, carbon cycle, effects of air pollution, emission inventory.

Surface meteorological observations: air temperature, relative humidity, barometric pressure, wind speed and direction, radiation and precipitation measurements. Upper air observations using radiosonde.

Wind stress, Ocean currents, Equatorial current systems, Wind driven ocean circulation, Ekman transports, Wind driven coastal currents, Western boundary intensification. Physical Characteristics of the Ocean: Ocean Basins, Properties of sea water & Temperature, Salinity, Density profiles. Mixing processes in the oceans, Upwelling and downwelling processes, Air-sea interactions: El Nino- Southern Oscillation (ENSO), Indian Summer Monsoon.