

Approved Course pattern and Syllabi w.e.f. 2007-2008 Academic Year

Credit System in M. Tech. Atmospheric Science

Course No. & Title	Periods per week			Sessional marks	Semester end marks	Total	Credits
	L	P	T				
I Semester:							
Theory:							
AS-501 General Circulation and Climate	4	-	4	20	80	100	4
AS-502 Physical Meteorology	4	-	4	20	80	100	4
AS-503 Fundamentals of Dynamic Meteorology	4	-	4	20	80	100	4
AS-504 Part A: Synoptic Meteorology Part B: Tropical Meteorology	4	-	4	10 10	40 40	50 50	4
AS-505 Physics and Dynamics of Oceans	4	-	4	20	80	100	4
Practicals:							
AS-506 Part A: Computer based meteorology Computations using Fortran 77 Part A: Computer based Oceanography Computations using Fortran 77	-	6	6	10 10	40 40	50 50	4
AS-507 Synoptic Analysis	-	6	6	20	80	100	4
AS-508 Viva-voce	-	-	-	-	50	50	2
Total	20	12	32	140	610	750	30
II Semester:							
Theory:							
AS-509 Observational Techniques	4	-	4	20	80	100	4
AS-510 Numerical Weather Prediction	4	-	4	20	80	100	4
AS-511 Part A: Fluid Mechanics Part B: Air- sea interaction	4	-	4	10 10	40 40	50 50	4
AS-512 Satellite Meteorology	4	-	4	20	80	100	4
AS-513 Part-A: Hydrometeorology Part-B: Agricultural Meteorology	4	-	4	10 10	40 40	50 50	4
Practicals:							
AS-514 Numerical Weather Prediction computations	-	6	6	20	80	100	4
AS-515 Hydrometeorology and Agricultural Meteorology computations	-	6	6	20	80	100	4
AS-516 Viva-voce	-	-	-	-	50	50	2
Total	20	12	32	140	610	750	30
III and IV semesters							
AS-517 Internship	12	-	12	-	-	200	8
AS-518 Dissertation	44	-	44	-	-	900	36
AS-519 Seminar	8	-	8	-	-	300	12
AS-520 Viva-voce	-	-	-	-	-	100	4
Total	64		64	-	-	1500	60
Grand Total (1+2+3+4 semesters)	104	24	128			3000	120

M.Tech. Atmospheric Science

I Semester syllabi

AS 501 : General Circulation and Climate

Unit I:

Earth's orbital characteristics - Seasonal and latitudinal variation of insolation - Net radiation - Heat balance of the atmosphere. Global, time mean fields of pressure, temperature and winds - troposphere and stratosphere - summer and winter.

Unit II:

Definition of the general circulation. Observed zonally averaged meridional and zonal circulations, hemispheric and zonally asymmetric components of the general circulation - standing eddies and Walker circulations, historical developments towards understanding the zonal mean circulations.

Basic equations - Toroidal and eddy fluxes - Angular momentum - sensible and latent heats and kinetic energy - balance requirements - maintenance of the zonal mean circulations.

Unit III:

Energetics of the atmosphere - Total potential energy, Available potential energy, zonal and eddy available potential energy - Energy exchanges.

Simple models of symmetric circulation and ITCZ; role of tropics in global general circulation. Results of dish pan experiments, Rossby and Hadley regimes.

Unit IV:

Monsoon circulations in the meridional and zonal planes - Energy conservation cycle of the monsoon circulation, energy exchanges between ultra-long, synoptic and short waves in the tropical upper troposphere during northern summer.

Unit V:

Definition of climates - climate change on different time scales - decadal centuries and millennia. Forcings influencing the climate and their variations, feedback processes between different forcings - inter annual variability - QBO, ENSO, their mechanisms.

Simple climate models and their results - Introduction to large numerical models.

Text Books:

1. Causes of Climate, J.G.Lockwood
2. Fundamentals of Dynamic Meteorology
3. The Nature and Theory of General Circulation of the Atmosphere, E.N.Lorenz, WMO Publication.

AS 502: **Physical Meteorology**

Unit I:

Radiative transfer in the atmosphere : Fundamentals, thermal radiation, spectral composition of solar radiation, absorption spectra of atmospheric gases, equation of transfer, optically thick and thin approximations, scattering, radiative cooling rate calculations, Green house effect, the radiative heat balance of the atmosphere, earth-atmosphere system, Green house effect, radiation and cloud feed back, radiation and albedo coupling, radiation and climate.

Unit II:

Atmospheric Thermodynamics : First law, internal energy, heat capacities, Second law, Maxwell's relations, water-air mixture, aerological diagrams - T- Φ gram, potential temperature, Equivalent temperature, virtual temperature, thermodynamic stability.

Unit III:

Cloud Physics : Types of clouds, Cloud microphysical processes, growth of cloud droplets, condensation, collision and coalescence, Bergeron-Findeisen theory, rain formation, cold and warm clouds, artificial rainmaking.

Unit IV:

Convection in the atmosphere : Thunderstorms, nature of the convective instability, turbulent convection, convection within atmosphere, thermodynamic structure of clouds and associated flow fields. Empirical formulae for the variation of saturated vapour pressure with temperature, Clapeyron's equation, Yanai's budget equations for moisture and heat to lay stress on heat sources and sinks.

Unit V:

Atmospheric Electricity : Global atmospheric electric circuit, atmospheric electric parameters, measurements, conductivity, role of ions in the atmosphere, electric field in thunder clouds and lightning.

Books for Study :

1. Physical Meteorology, B.J.Rettalack, WMO Compendium of Meteorology, 1973, Vol.1, No.2.
2. A Short Course in cloud Physics, R.R.Rogers and M.R.Yau
3. Atmospheric Electricity, J.A.Chalmers
4. Physical Meteorology, H.G.Houghton, MIT Press

Books for Reference :

1. Physical Meteorology, Johnson
2. Atmospheric Science - An Introductory Survey, J.M.Wallace and P.V.Hobbs
3. Cloud Physics, B.J.Mason
4. Elements in Cloud Physics, R.R.Rogers
5. Atmospheric Thermodynamics, J.V.Iribarne and W.L.Godson

AS 503: Fundamentals of Dynamic Meteorology

Unit I:

Forces governing the atmospheric motions and their classifications as body and surface forces, conservative and nonconservative forces, equation of motion in rotating frame, Coriolis force and its physical nature, Rossby number.

Unit II:

Geostrophic flow and its application to meteorological chart analysis, gradient flow and its application to atmospheric vortices including tornadoes and tropical cyclones, continuity equation (conservation of mass), thermo dynamic equation, angular momentum and kinetic energy equation, total potential energy, conservation of total energy.

Unit III:

Hydrostatic approximation, corresponding approximation in the equation of horizontal motion, pressure as vertical coordinate, atmospheric equations in pressure coordinate system, shallow water equations.

Unit IV:

Circulation, vorticity, divergence and deformations; circulation theorems of Kelvin and Bjerknes, applications of the circulation theorem - land and sea breezes and other examples; Helmholtz theorem; barotropic and baroclinic atmosphere; vorticity equation; potential vorticity of barotropic and baroclinic flow; divergence equation, linear and non-linear balance equations' scale analysis of vorticity and divergence equations for planetary and synoptic scale motions; quasi-geostrophic approximation; quasi-geostrophic omega equation, thermal wind equation, backing and veering of wind in relation to horizontal temperature advection barotropic vorticity equation, beta-plane approximation, Rossby wave; quasi-geostrophic.

Unit V:

The mechanism of pressure change, kinematics of pressure system, pressure tendency equation; Holmboe theory of the motion of pressure systems; isallobars and isallobaric wind; Sutcliffe's theory of the development of pressure systems and related ideas.

Books for Study :

1. An Introduction to Dynamic Meteorology, J.R.Holton
2. Numerical Prediction and Dynamic Meteorology, G.J.Haltiner and R.T.Williams.

Books for Reference :

1. Dynamical and Physical Meteorology, G.J.Haltiner and Martin
2. Dynamic Meteorology, B.Haurwitz
3. Dynamic Meteorology, Panchev
4. Dynamic Meteorology, Ed.Wiin Nielsen, WMO Publication

AS-504 Part-A: Synoptic Meteorology

Unit I:

Synoptic data and collection: Surface and upper air weather data transmission- Code for inland, coastal and ship stations. Upper air data – PILOT and TEMP codes. Station models, Weather charts.

Air masses and fronts: Air mass production – Classification – Sources of air masses in winter and summer and their modification. Fronts and frontal surfaces – Principal frontal zones – frontogenesis and frontolysis. Extra-tropical cyclones- formation – Life cycle – Structure and movement. Anticyclones and blocking. Heat and cold waves.

Unit II:

Kinematics of the pressure field: Characteristic curves – General expressions for their velocity and acceleration – Movement of troughs, ridges and pressure centres, Intensification and Weakening, deepening and Filling of surface pressure systems.

Kinematics of the wind field: Relation between streamlines and trajectories. Trajectories in moving cyclones and anticyclones. Differential properties of the wind field. Application of geostrophic, gradient, thermal winds, divergence and vertical velocity computations.

Unit III:

Indian monsoon: Land and sea breezes – Definition of monsoon – Synoptic features associated with onset, withdrawal, active and break monsoon situations. Rainfall distribution and rain bearing systems during summer monsoon season - monsoon depression, Mid-tropospheric cyclones and Onset vortex . Winter monsoon.

Prediction of weather elements: Maximum and minimum temperatures – Fog – Hail storm. Aviation Meteorology: Meteorological hazards to aviation – Take-off, landing, in-flight, - Icing, turbulence, CAT, visibility and fog.

Text Books:

1. Weather analysis and forecasting – Vol.1 & 2 by B. Patterson
2. Tropical meteorology by H. Riehl
3. Climate and circulation of the tropics by S. Hasternath

Reference:

1. Monsoon meteorology by C.S. Ramage
2. Jet stream meteorology by E.R. Reiter

AS- 504 Part-B: Tropical Meteorology

Unit I:

Wind systems of tropics: Low level general circulation, Seasonal variation of surface circulation, world distribution of surface winds and pressures, equatorial trough, lows, highs, depressions, Trade wind inversion over Indian Ocean

Tropical cyclones: Formation, movement, life cycle, surface and upper air structures, budgets of momentum and energy, eye and eye wall cloud, spiral cloud bands, intensity, forecasting, storm surges

Unit II:

Global perspective of monsoons, Long range prediction of the southwest monsoon onset and rainfall over India, ITCZ over Indian Ocean - Structure and movement, 30-50 day Oscillations. Interannual variability: Monsoon variability in interannual and decadal time scales, Atmospheric -Ocean surface patterns of Southern Oscillation, El-Nino, La Nina, ENSO, Walker circulation, Hadley circulation, Tropical Biennial Oscillation, Indian Ocean dipole mode,

Unit III:

Regional Circulation systems: Jet streams- Definition and characteristics, Tropical Easterly jet, Subtropical Westerly jet, Somali jet over India. Easterly waves - structure, model and movement; Rossby waves and Kelvin waves.

Mesoscale systems: Thunder storms - CAPE and CINE, Influence of vertical wind shear - Dust storm (Andhi), Kalabaisaki, Hail storm, mesoscale convective systems- influence of orography, fog, diurnal variations, mesoscale vortices.

Text books:

1. Weather analysis and forecasting - Vol.1 and 2 by B. Petterson
2. Tropical Meteorology by H. Riehl
3. Climate and circulation of the tropics by S. Hastenrath

References:

1. Monsoon meteorology by C.S. Ramage
2. Jet stream meteorology by E.R. Rieter
3. Southwest monsoon by Y.P.Rao
4. Monsoon Meteorology by C.P. Chang and T.N. Krishnamurti
5. Tropical Meteorology Vol 1 and 2 by G.C.. Asnani
6. Climate and Weather in the Tropics by Herbert Riehl

AS 505 : Physics and Dynamics of Oceans

Unit I:

Physical Properties: Physical properties of the seawater: Salinity, Chlorinity and their determination, Salinity and temperature distribution in the world oceans, Density parameters, Specific volume anomaly.

Unit II:

Oceanographic Instruments: Temperature measurements; Protected and Unprotected reversing thermometers, MBT, XBT, CTD. Current measurements; Lagrangian and Eulerian methods with examples, Andhera current meter, Position fixing at sea. GPS, Wave raider buoys, Tide gauges.

Unit III:

Air-sea interaction: The significance of Air-Sea Interaction; Atmospheric and Oceanic Interaction at various scales; Concept of Boundary Layer ; Atmospheric Heat Budget; Variations of wind, temperature and moisture over the sea surface. Air sea temperature differences; Wind stress and resultant drag coefficient with variation to wind speed; Upper ocean boundary layer. Oceanic heat budget.

Unit IV:

Waves and Tides: Waves and Tides; wave characteristics, wave generation, Sea and Swell, Deep and Shallow water waves. Tides; their causes, variation, and types, Tidal currents.

Unit V:

Ocean Dynamics: Ocean Circulation; Ekman Spiral, Vertical circulation, Thermohaline circulation, Westward intensification of currents. warm and cold currents of the major world ocean. seasonal currents in the North Indian Ocean. El Nino, La Nino, T-S Diagram and water masses of the world ocean.

Text Books:

1. Introduction to Principles of Physical Oceanography by Pierson and Neumann
2. The Oceans by Sverdrup et al
3. Elements of Physical Oceanography by Mc Lellan
4. Introductory Dynamic Oceanography by S. Pond & G.L. Pickard

**AS:506 Part A: Computer based Meteorology computations
using FORTRAN**

Programming in FORTRAN 77:

Characters used in FORTRAN: Fortran Constants; Fortran Variables; Type declaration for integers; Arithmetic expressions; Input Output Statements
Control Statements; Do Statement; Subscripted variables; Format specifications; Functions and Subroutines; Processing files in Fortran; Character manipulation in Fortran; Miscellaneous Fortran 77 features; Double precision, Complex quantities; DATA Statement, Implicit Declaration; Execution time format declaration

Exercises:

1. Calculation of zonal and meridional wind components from wind direction and wind speed.
2. Calculation of horizontal divergence from wind data

3. Calculation of absolute vorticity from wind data
4. Calculation of geostrophic wind
5. Calculation of gradient wind
6. Calculation of thermal wind
7. Calculation of vertical velocity
8. T - Φ gram analysis: analysis of aerological data
 - Potential temperature
 - Equivalent temperature
 - Equivalent potential temperature
 - Lifting condensation level
 - Equilibrium level
 - Stability indices
9. Elsasser's Radiation chart: Flux determination

AS 506 Part-B: Computer based Oceanography computations
using FORTRAN

Exercises:

1. Determine the Density using Temperature and Salinity
2. Determine the Specific volume anomaly using Temperature, Salinity and Depth
3. Identification of up welling and sinking patterns
4. Computation of relative currents
5. Stability characteristics of water column and Richardson number
6. Estimation of tides
7. Preparation of T-S Diagram
8. Computation of wind stress
9. Computation of latent, Sensible heat fluxes at the ocean surface.
10. Computation of evaporation

AS 507 : Synoptic analysis practical

1. Analysis of thermodynamic diagram (T-0 diagram)
2. Time and cross sections
3. Plotting surface and upper air data
4. Analysis of mean climatic data ; Pressure, Temperature, Rain
Rainy-days, Fog and Thunderstorms representative of winter
5. Analysis of mean climatic data; Pressure, Temperature, Rain,
Rainy-days, Fog and thunderstorms representative of summer.
6. Analysis of surface and upper-air charts - Monsoon depressions
7. Analysis of surface and upper-air charts - Tropical Cyclones
8. Analysis of surface and upper-air charts - Western disturbances
9. Analysis of surface and upper-air charts - Break monsoon
10. Analysis of surface and upper-air charts – Active monsoon

II Semester

AS-509: Observational Techniques

Unit I:

Measurement of temperature: Response times of Thermometers, Liquid in glass Thermometers, Electrical Resistance thermometers, Semiconductor Thermometers, Bimetallic Thermometers, Thermocouples.

Measurement of Atmospheric Pressure:

Mercury barometers-Fortin and Kew, Corrections of Barometer reading to standard conditions, Aneroid Barometers, Piezo – resistive Barometers.

Measurement of Humidity: Psychrometer, Hair Hygrometer, Dew point Hygrometer, Electrical Resistive and Capacitive Hygrometer, Hygrometer using absorption of electromagnetic radiation.

Unit II:

Measurement of Surface wind: Wind vane, Cup anemometer, Hotwire Anemometer, Pressure tube Anemometer, Sonic Anemometer.

Measurement of Precipitation: Non-recording precipitation gauges, Recording precipitation gauges, Weighing gauges, Float gauge, Tipping-bucket gauge, Optical rain gauge.

Measurement of Radiation: Angstrom electrical compensation Pyrheliometer, Eppley Pyranometer, Moll Gorczynsky Pyranometer, Net Radiometer, Pyrgeometer

Unit III:

Measurement of Visibility: Visual estimation of meteorological optical range, Visual Extinction meter, Scopograph Transmissometer.

Measurement of upper air pressure, temperature and Humidity: Radio sonde – Types of Radiosondes, Temperature sensors, Pressure sensors, Relative humidity sensors.

Measurement of upper wind: Sensors and instruments for upper wind – Optical theodolite, Radio theodolite, Radar tracking using radio navigational signals- Omega networks, Loran-c chains, Global positioning system, Pilot balloon observation.

Meteorological Observations from Ships.

Unit IV:

Measurement of Ozone: Measurement of surface ozone, Measurement of total ozone - Dobson spectrophotometer, Ozonesonde Satellite measurement backscatter ultraviolet measurements.

Special Profiling techniques for the boundary layer and the troposphere: Ground based remote sensing techniques, Sodars, Radio acoustic sounding system, Lidars.

Unit V:

Radar Measurements: The weather radar precipitation estimation, radar equation for precipitation targets. Doppler radar – Velocity measurements, Radar wind profiler – MST Radar.

Basic concepts of Satellite Sensors: Advance very high resolution radiometer – AVHRR, very high resolution radiometer – VHRR, visible and infrared spin scan Radiometer Atmospheric sounder – VAS, special sensor microwave imager – SSM/I, High resolution infrared Radiation sounder – HIRS, microwave sounding unit-MSU, Scatterometer, Synthetic Aperture Radar, Altimeter, Ocean Colour Monitor-OCM.

Reference Books:

1. Guide to Meteorological Instruments and Methods of Observation. Sixth edition. WMO-No 8.
2. Compendium of lecture notes on Meteorological instruments. WMO-No 622.
3. Air-Sea interaction. Instruments and methods edited by F.Dobson, L.Hasse and R.Davis , premium press – New York.
4. Satellite oceanography – An introduction to oceanographers and remote sensing scientists I.S.Robinson, Ellis Horward Limited
5. Satellite Meteorology – An Introduction, Stanely Q Kidder, Thomas H VanderHaus, Academic Press Inc

AS 510: Numerical modeling of weather and climate

Unit I:

Basis of NWP: Fundamental equations; Derived Set of Equations; Types of pure Waves: Sound, gravity and Rossby waves; mixed Rossby- gravity waves. Filtering method.
Numerical methods: Finite difference methods- forward and Centered and Implicit schemes; CFL Criterion; Non Linear Instability and Aliasing; Semi Implicit Method
Lax Wendroff Scheme

Unit II:

Numerical Models: Quasi Geostrophic Models: Barotropic, Baroclinic and Multi Level Baroclinic Models
Numerical methods: Relaxation methods Arakawa Jacobian
Linear and Non Linear Balance Models
Primitive Equation Models: Sigma Coordinates; Problem of initialization for PE models. Two Level PE Model in Momentum form; Staggered Grid Systems- Arakawa C grid.

Unit III:

Parameterization of Physical Processes:
Boundary Layer : Reynolds Equations, Bulk Formulae, and Deardorf Model
Cumulus Convection : Convective Adjustment Scheme, Kuo Scheme
Radiation : Short and Long Wave radiations Clear and Cloudy Sky -Katayama scheme

Unit IV:

General Circulation and Climate Modelling: Introduction to Climate Modelling.
Types of Climate Models: 0-D and 1-D models: Energy Balance Models; Radiative Convective Models Two dimensional Statistical Dynamical Models.

3-D GCMs. Design of 3-D GCMs- various components, parameterization of sub-grid scale processes in GCMs. Philips two-layer GCM experiment. Climate simulation with GCMs. Climate sensitivity experiments.
Spectral General Circulation Models: spectral method, Spectral Transform Technique, Spectral Model of Shallow Water Equations.

Unit V:

Operational Numerical Weather Prediction: Description of a NWP System and its Components
Data Processing,

Objective Analysis: Cressman scheme; Optimum Interpolation Method

Initialization: Static Initialization, Variational Normal Mode Initialization

4 Dimensional Data Assimilation . Newtonian Relaxation

AS- 511 Part A: Fluid Mechanics

Unit I:

Continuum hypothesis, Lagrangian and Eulerian description of fluid motion. General equation of motion, - equations of motion of an inviscid fluid - continuity, and Euler's equation of motion, Irrotational motion, Bernoulli's equation. Derivation of Navier-Stokes equations of motion and its applications.

Unit II:

Kelvin's circulation theorem, Two dimensional motion - stream function, velocity potential, Helmholtz's theorem - Complex potential, Basic - Singularities - Sources, sink, Doublet Rankine's Techniques of constructing stream lines Korman's vortex street, method of images - Circle theorem, Dynamical principle of similarity.

Unit III:

Boundary layer theory - Introduction, Laminar flow and shift to turbulent flow - Two dimensional boundary layer equations, Derivation - Boundary layer characteristics - Momentum and kinetic energy integral equations - Bernard convection.

Books for Study :

1. Fluid Mechanics, Landau and Lifshitz
2. Geophysical Fluid Dynamics, J.Pedlosky
3. Introduction to Fluid Dynamics, McLeod, E.B.
4. A First course in Fluid Mechanics, R.H.Sobersky and A.S.Acosta
5. Essential of Fluid Dynamics, Prandtl
6. Atmospheric Turbulence, Panofsky and Dutton

Book for Reference :

Hydrodynamics, H.Lamb

AS- 511 Part-B: Air – Sea Interaction

Unit I:

The significance of Air-Sea Interaction; Atmospheric and Oceanic Interaction at various scales; Concept of Boundary Layer ; Atmospheric Heat Budget; Variations of wind, temperature and moisture over the sea surface. Air sea temperature differences; Wind stress and resultant drag coefficient with variation to wind speed; Upper ocean boundary layer. Oceanic heat budget.

Unit II:

Physical interaction between the ocean and atmosphere; Radiation, Heat exchange through latent and sensible heat; Oceanic forcing by air-sea exchange of moisture and heat; Momentum transfer and drag; Oceanic impact on the marine atmospheric circulation.

Unit III:

Large Scale Air-Sea Interaction: Ocean – Atmosphere interaction in tropics
Characteristics of ENSO; ENSO and Air – Sea coupling; ENSO and the Indian Monsoon
Warm Pool in Indian and Pacific Oceans

Books:

1. Atmosphere – Ocean Dynamics, Adrian E. Gill, 1992.
2. Climate and Circulation of the Tropics, S. Hastenrath, 1988.
3. The Oceans and climate by G.R. Bigg, 1996.
4. Ocean – Atmosphere interaction and climate modeling, Beris A. Kagan, 1995

AS 512: Satellite Meteorology

Unit I:

Physical basis of remote sensing - Remote sensing of the environment with Electromagnetic energy - Atmospheric transmission, atmospheric window regions and absorption bands.

Kepler's laws of universal planetary motion, Meteorological satellites and their orbital characteristics, Geostationary, Sun-synchronous, Polar and special purpose orbits, Different meteorological satellite systems- Meteosat series, NOAA series, TRMM and SSMI series, QUICKSCAT etc and future programmes - MEGATROPICS satellite. Global weather satellite system.

Unit II:

Satellite analogue data: Satellite image interpretation and enhancement techniques, cloud type identification and Neph analysis, Synoptic scale weather systems, Mesoscale weather systems

Tropical cyclones, Tropical cyclone categorization of different stages, Estimation of central pressure by using Dvorak's technique and extra tropical cyclones.

Unit III:

Remote sensing of atmospheric variables: Schwarzschild's Equation and its solution, Vertical sounding, Limb sounding, No emission equation, Detection of Aerosols by satellites.

Satellite digital data: Retrieval techniques, SST, Cloud top temperature, methods of retrieval algorithms for temperature and humidity profiles, Cloud motion wind vectors. Radiation budget.

Unit IV:

Tropical phenomena, Method of analysis of tropical disturbances, Mesoscale circulation patterns, Sea and land breeze circulations, orographic pattern;

Application of satellite data for the study of southwest monsoon namely-onset of monsoon, active, break cycle, seasonal monsoon rainfall, low frequency oscillations.

Unit V:

Rainfall monitoring by VIS and IR data, Cloud Indexing Method, Bispectral techniques, Life History Techniques, Cloud Model Techniques.

Active and passive microwave sensors and their application for ocean surface winds, sea surface temperature, soil moisture.

References:

1. Introduction to Environmental Remote Sensing - E.C. Barette and L.F. Curtis
2. The use of satellite data in rainfall monitoring- E.C. Barette and D.W. Martin
3. Remote sensing of atmosphere - J.T. Houghton, F.W. Taylor and C.D. Rodgers.
4. Satellite Meteorology - An introduction - S.Q. Kidder and T.H. Vanderhour
5. Introduction to Meteorological and other environmental satellites - WMO Publication
6. Remote sensing of atmosphere and Oceans - A Deepak
7. Training course on satellite meteorology techniques and applications - ISRO publication.
8. Lecture Notes for Post Graduate Course on Satellite Meteorology and Global Climate, Vols.1, 2 and 3. ISRO Publications

AS – 513 : Part A Hydrometeorology

Unit I:

Hydrological Cycle – Terrestrial and atmospheric branches, mass balance- rainfall over catchments, DAD Curves, Storm models – Probable maximum precipitation using storm models.

Unit II :

Soil water – measurements – infiltration indices – rainfall – runoff models -Evaporation – direct and indirect methods for ET –Hydrographs – Unihydrograph – Synthetic hydrograph – flood hydrograph – flood and stream flow routings.

Unit III:

Modelling – Parameterization of land – surface processes in AGCMS – Sensitivity of climate to land surface conditions – Dynamic hydro-thermal balances at macroscale.

References:

1. Dynamic Hydrology – PS.Eagleson

2. Hydrometeorology - C.J.Wiesner
3. Land surface process in AGCMS (Ed) P.S.Eagleson, 1982
4. Articles authored by P.S.Eagleson and Y.Mintz.

AS – 513 Part B : Agricultural Meteorology

Unit I:

Climate near the ground and agriculture – Vertical flux of moisture and heat – Bare Soil – Water transport – Capillary conductivity and water content – soil water diffusivity – infiltration – heat transfer in soil – thermal conductivity and diffusivity – surface soil heat flux.

Unit II:

Vertical fluxes of heat and moisture at a vegetated land surface – soil – plant – atmospheric continuum model – soil evaporation – potential transpiration – methods of assessing water use by plants – vapour flow methods – energy balance model - aerodynamic model – eddy correlation model – land surface parameterization of schemes – Bucket model – Soil hydrology models - SiB – SSiB.

Unit III:

Climate and food : Climate and grain production – teleconnections – drought and increasing atmospheric CO₂ -agro meteorological forecasting – crop yield forecasts.

References:

1. Dynamic Hydrology – P.S.Eagleson
2. Land surface process in AGCMS (Ed) - P.S.Eagleson, 1982
3. Articles authored by D.J.Carson, W.H.Brutsaert, L.J.Fritschen
4. Chapters 5 & 8 from World Climatic Systems, John G Lockwood.

AS -514 Lab –III : Numerical Weather Prediction Computations

1. Computation of vorticity using geopotential height: Solution of Laplacian
2. Computation of advection : Solution of Jacobian
3. Relaxation for solution of barotropic vorticity equation
4. Preparation of computer code for (3) to obtain tendency field
5. Computation of surface fluxes
6. Numerical computation of LCL
7. Numerical computation of moist adiabat
8. Computation of heating rates –Kuo scheme
9. Barotropic Instability
10. Baroclinic Instability

AS-515: LAB IV: Hydrometeorology and agricultural meteorology computations

1. Average depth of rainfall over a river basin

2. Evapotranspiration models
3. Determination of precipitable water
4. Soil moisture models
5. River yield forecasting
6. Unit Hydrograph- modeling
7. Daily water balance model – irrigation
8. Flood formulae and envelope curves
9. Growing periods- Crop performance
10. Net radiation –Energy balance components