



**ANNA UNIVERSITY: : CHENNAI - 25**

**FACULTY OF CIVIL ENGINEERING**

**Approved Special Electives for  
M.S. / Ph.D. Degree Programs  
(upto 17<sup>th</sup> AC 27.04.2012)**

ANNA UNIVERSITY :: CHENNAI – 600 025.

SPECIAL ELECTIVES FOR FACULTY OF CIVIL ENGINEERING

COURSE CODE	COURSE TITLE	L	T	P	M/C
	Corrosion Engineering	3	0	0	3
FC1911	<a href="#">Networking Technology And Social Aspects In Rural Water Supply</a>	3	0	0	100
FC1912	<a href="#">Exploration in Heuristic And Optimal Decisions</a>	3	0	0	100
FC1913	<a href="#">Public Transportation</a>	3	0	0	100
FC1914	<a href="#">Bus Transport Management</a>	3	0	0	100
CZ 040	<a href="#">Climate Change Mitigation And Adaptation</a>	3	0	0	3
FC9001	<a href="#">Environmental Nanotechnology</a>	3	0	0	3
FC9002	<a href="#">Reliability Analysis And Performance Based Design</a>	3	0	0	3
FC9003	<a href="#">Research Methodology</a>	3	0	0	3
FC9004	<a href="#">Random Vibrations</a>	3	0	0	3
FC9005	Water Pollution and its Health Impact Assessment	3	0	0	3
FC9006	Geomatics In Meteorology	3	0	0	3
FC9007	Human Factors In Road Accident Occurrence	3	0	0	3
FC9008	Land Use Transportation Modelling	3	0	0	3



**CORROSION ENGINEERING****L T P C  
3 0 0 3****1. INTRODUCTION:**

Cost of Corrosion – Corrosion Engineering – Definition of Corrosion – Environments – Corrosion Damage – Classification of Corrosion.

Corrosion Principles : Introduction – Corrosion Rate Expressions. Electrochemical Aspects : Electrochemical Reactions – Polarisation – passivity, Environmental Effects: Effect of oxygen and oxidizers – Effect of Velocity – Effect of temperature – Effects of Corrosive concentration – Effect of Galvanic Coupling – Metallurgical Aspects.

**2. FORMS OF CORROSION**

Galvanic Corrosion : EMF and Galvanic Series – Environmental Effects – Distance Effect – Area Effect – Prevention. Crevice Corrosion: Environmental Factors – Mechanism – Combating Crevice Corrosion – Filiform Corrosion. Pitting – Solution composition – Velocity – Metallurgical Variables – Evaluation & Prevention of pitting damage. Intergranular corrosion . Austenitic Stainless Steels – Weld Decay – Knife Line Attack.

Selective Leaching: Dezincification Characteristics, Mechanism, prevention – Graphitization – Other Alloy systems. Erosion Corrosion: Surface Films – Velocity – Turbulence – Impingement - Galvanic Effect – Combating Erosion corrosion. Stress corrosion: crack morphology – Stress effects – time to cracking – Environmental & Metallurgical factors – Mechanism – methods of prevention – corrosion Factors – Hydrogen Blistering – Hydrogen Embrittlement – Prevention.

**3. CORROSIVE ENVIRONMENTS**

Mineral Acids: Sulfuric Acid – Nitric Acid – Hydrochloric Acid – Hydrofluoric Acid – Phosphoric Acid. Organic Acids – Alkalies – Atmosphere Corrosion – Sea water – Fresh water – High purity water – soils – Aerospace – Biological corrosion – Human body – Corrosion of metals by halogens – Liquid metals and fused salts – sewage and plant – waste treatment – Dew point corrosion – liquid metal embrittlement of cracking – Hydrogen peroxide – Rebar corrosion.

**4. CORROSION TESTING**

Introduction – Classification – Purpose – Materials and specimens – surface preparation – Measuring & Weighing – Exposure Techniques – Duration – Planned Interval Tests Aeration – Cleaning specimens after exposure – temperature – Standard expressions for corrosion rate – Galvanic corrosion high temperature and pressure – Erosion – Intergranular corrosion – pitting & stress corrosion – NACE Test methods – Linear polarization – paint Tests – Sea water tests – Miscellaneous tests of metals.

**5. CORROSION PREVENTION**

Materials Selection: Metals & Alloys – Metal purification. Alteration of Environment: changing mediums – Inhibitors. Design: Wall Thickness – Design Rules. Cathodic & Anodic protection – comparison. Coatings: Metallic & other Inorganic coatings – Organic coatings – corrosion control standards – Failure Analysis.

**REFERENCES:**

1. Mars G. Fontana, corrosion Engineering Third Edition Mc. Graw – Hill Book Company, New York 1988.
2. J. H. Brophy, R. M. Rose and J. Wulf, "The structure and properties of materials," wiley interscience Inc., New York, 1994.

**FC1911 (Old Code EN 040) NETWORKING TECHNOLOGY AND SOCIAL ASPECTS IN RURAL WATER SUPPLY**

**3 0 0 100**

**UNIT I INTRODUCTION 7**

Social structure and Social function – Methods of Sociology – Social Organisation – Sociology and other Social Sciences – Social Effect of Technology – Role of Science and Technology on Development.

**UNIT II SOCIOLOGY AND ENVIRONMENT 8**

Man and Environment – Kinds of Environment and Social life – Environmental Issues for Projects – Global issues – National issues – Regional issues and Social Issues.

**UNIT III SCIENCE AND TECHNOLOGY IN ENVIRONMENT 10**

Integrating Environment and Technology – Resource Use in Society - Measuring Resource Scarcity –Environment Database management – Water Treatment Techniques and Biotechnology in Rural Water Supply System. Need for improvement in Rural Water Supply System.

**UNIT IV LAW / MANAGEMENT / ECONOMICS 10**

National Polices for Environment Awareness and Protection – Air Act, Water Act, Solid Waste and Hazardous Waste – EIA – Environmental Marketing – Principles of Cost Benefit Analysis - Gender budgeting – Auditing.

**UNIT V RURAL SOCIOLOGY 10**

Rural urban Contrast – Significance of Village Communities in India – Source of Water Supply in Rural India and Rural Tamilnadu. Participation of NGO's in Rural Water Supply System – Women Participation Women Participation – Women Education and Technology Adaption.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Desai A. P. Rural Sociology in India, Popular Prakashan, Bombay, 1969.
2. Abraham Mark, Social Research Methods, Prentice – Hall Inc. Eaglewood Cliffs, N.J. 1983.
3. Roger Perman, Yue Ma and James McGilvray (1997) “Natural Resources and Environmental economics” Second edition, Addison Wesley Longman Ltd, Singapore.
4. Kolluru, R.V. Environmental Strategies Handbook, McGraw Hill, New York, 1991.
5. Manual on “Water Supply and Treatment” CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.

**FC1912 (Old Code RS 083)      EXPLORATION IN HEURISTIC AND OPTIMAL DECISIONS      3 0 0 100**

**UNIT I      INTRODUCTION TO WATER RESOURCES SYSTEM OPERATION      9**

System – input – output – operation objectives – controls – alternative methods of operation.

**UNIT II      SIMULATION ANALYSIS OF CANAL SYSTEM      9**

Approaches to analysis of water resources system in operation system modeling and constraints - simulation analysis for canal operation.

**UNIT III      PROGRAMMING MODELS      9**

Review of Programming models in canal operation – identification and formulation of system model constraints – objectives function –linear programming for allocation of water.

**UNIT IV      HEURISTIC ANALYSIS      9**

Features and problems in water allocation from canals – Need for heuristic approach identification of constraints – objectives of approach – heuristic analysis.

**UNIT V      MIXED INTEGER PROGRAMMING MODELS      9**

Operational requirement of canals – alternative strategies – mixed integer programming in canal operation.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Jerry Banks and John S. Carson, Barry L. Nelson, David M. Nicol, "Discrete event system simulation ", Prentice Hall, India, 2000.
2. Montgomery, D.C. and Johnson, L.A., Forecasting and Time Series Analysis, McGraw Hill Book Company, 1976.
3. Taha H.A. Operations Research – An Introduction, Prentice Hall of India Pvt. Ltd., New Delhi, 6<sup>th</sup> edition, 1997.
4. Pinder G.F. and Gray, W.G., Finite Element Simulation in Surface and Subsurface Hydrology, Acd. Press, 1977.
5. Narsingh Deo., System Simulation with Digital Computer, Prentice – Hall of India Pvt, Ltd., New Delhi, 1998

**FC1913                      PUBLIC TRANSPORTATION                      3 0 0 100**

**UNIT I                      INTRODUCTION                      9**

Basic Characteristics of Different Public Transport Modes – Role of Public Transportation – Problems of Public transportation – The Govt. Policy

**UNIT II                      O-D SURVEY                      9**

Need - O-D survey methods – O-D matrix- Desire line chart – Public Transport Surveys Inventory of Public Transport Buses.

**UNIT III                      TRAVEL DEMAND ESTIMATION                      9**

Estimating Demand – Various Mode Split Modes – Model Calibration – Future Public Transport Demand.

**UNIT IV                      BUS ROUTE NETWORK PLANNING                      9**

Routing Rules – Factors in Route Planning – Types of Bus Networks – Radial Patterns, Grid Type Networks, Radial Criss – Cross, Trunk Line With Feeders, Timed Transfer Networks – Layover Time – Through Routing.

**UNIT V                      SCHEDULING                      9**

Policy Headways-Peak to Base Ratio – Staggered Work Hours – Mariginal Ridership Approach.

**TOTAL : 45 PERIODS**

**REFERENCE:**

1. Public Transportation by George E.Gray, Lesker A.Hoel, Prentice Hall, INCSummer School Notes on Urban Mass Transmit System Planning, N.V. Ramamurthy, REC, Warangal.

**FC1914                      BUS TRANSPORT MANAGEMENT                      3 0 0 100**

**UNIT I                      ORIGINAL STRUCTURE                      9**

Organizational Structure in State Transport Undertakings(STU's) – Fleet Strength and Utilization – Vehicle Types – Bus Body Standardization – Capacity Criteria.

**UNIT II                      COMPONENTS                      9**

Cost identification and their variability – Fare Structures - Fare Collection Systems – Revenue leakage, Prevention and Checking Systems.

**UNIT III                      PERFORMANCE INDICATORS                      9**

Performance indicators – Operator, User Oriented, Productivity Indicators Selection of important Parameters – Strength and Weakness of STU's.

**UNIT IV                      TOTAL QUALITY MANAGEMENT                      9**

Total Quality Management in STU's – Need for new operational strategies Quality of service and its Importance.

**UNIT V                      EFFICIENCY AND EFFECTIVENESS                      9**

Improvement of Efficiency and effectiveness Depot layout location –Twin depot concept Inter modal transfer facilities.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Public Transport' Its Planning, Management and Operation, UCL, Press Ltd, London by Peter White.
2. Productivity in Road Transport, Santhosh Sharma, ASRTU Publication, New Delhi.



**CZ040 CLIMATE CHANGE MITIGATION AND ADAPTATION L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To Provide an overview of global climatological changes, their environmental impacts and mitigative and adaptative measures using scientific and economic instruments.

**UNIT I ELEMENTS OF CLIMATOLOGY 5**

Paleoclimatology, Paleo-indicators of climate, Factors affecting global, regional and local climates. Tropical, Monsoon, Polar, Desert, Mid-latitude climates and their role in global climate change.

**UNIT II GREENHOUSE GASES 10**

Carbon dioxide, methane, nitrous oxide, water vapor, ozone and chlorofluorocarbons – Chemistry of greenhouse gases, sources and sinks, their cycle in atmosphere, radiative forcing, effects on plants and animals and instruments used for quantification.

**UNIT III IMPACTS OF GLOBAL CLIMATE CHANGE 15**

Major environmental impacts of greenhouse gases. The greenhouse effect – ecosystems and species interactions, storms, thunderstorms, tornadoes, changes in agricultural production, droughts, spread of epidemics, wildfires and other extreme weather events. Nuclear winter.

**UNIT IV CLIMATE CHANGE AND ECONOMIC INSTRUMENTS 7**

Joint implementation, clean development mechanism, emission trading, carbon credits – industrial and individual level. Case studies on the economic instruments.

**UNIT V CLIMATE CHANGE MITIGATION / ADAPTATION 8**

International agreements and protocols, role of fossil fuels in climate change, future use of renewable energy, Role of Governments, industries, and individuals, traditional practices to cope with climate change impacts.

**TOTAL: 45 PERIODS****REFERENCES:**

- Ruddiman. W.F., Earth's Climate: Past and Future, W.H. Freeman and Company, 2001.
- Houghton. J.T., et al., (eds.), Climate Change 2001: The Scientific Basis, Cambridge University Press, Cambridge, U.K. 2001.
- Charles Kolstad, Environmental Economics, Oxford University Press, 1999.

**FC9001 ENVIRONMENTAL NANOTECHNOLOGY 3 0 0 3****OBJECTIVES:**

The objective of this course is to give an exposure on the preparation and characterization of nanomaterials used to destroy and detect constituents of environmental threat.

**UNIT I GENERAL 9**

Background of nanotechnology, particle size and surface area, quantum dot, converging science and technology, nanotechnology as a tool for sustainability, health, safety and environmental issues.

**UNIT II SYNTHESIS AND FABRICATION OF NANOMATERIALS 9**

Preparation of nanoscale metal oxides, metals, CNT, functionalized nanoporous adsorbents, nanocomposites - Chemical Vapour Deposition, sol gel, sonochemical, microwave, solvothermal, plasma, pulsed laser ablation, magnetron sputtering, electrospinning, Molecular imprinting.

**UNIT III CHARACTERISATION OF NANOMATERIALS 9**

AFM, STM, SEM, TEM, XRD, ESCA, IR & Raman, UV-DRS of nanomaterials for structural and chemical nature.

**UNIT IV OTHER FEATURES OF NANO PARTICLES 8**

Nanoparticle transport, aggregation and deposition, Energy applications - H<sub>2</sub> storage.

**UNIT V ENVIRONMENTAL APPLICATIONS 10**

Gas sensors, microfluidics and lab on chip, catalytic and photocatalytic applications, Nanomaterials for groundwater remediation, nanomaterials as adsorbents, membrane process.

**TOTAL: 45 PERIODS****REFERNCES:**

1. Glen E. Frywell and Guozhong Cao, 'Environmental Applications of nanomaterials-Synthesis, Sorbents and Sensors', World Scientific Publishing Co. Inc. USA, May 2007.
2. Mark Wisener, Jean Yves Bottero, 'Environmental nanotechnology', Mc Graw Hill, 2007.
3. Rao.C.N.R., Muller.A, Cheetham.A.K., 'The Chemistry of nanomaterials, synthesis, properties and applications', copyright at 2004 WILEY-VCH VerIsh HmbH & Co. KgaA, Weinheim.Bharat Bhushan, 'Handbook of nanotechnology' Springer, 2004.
4. Louis Theodore and Robert G.Kunz, 'Nanotechnology: Environmental Implications and Solutions', John Wiley & Sons, Inc Publication, New Jersey, 2005.

<b>FC9002</b>	<b>RELIABILITY ANALYSIS AND PERFORMANCE BASED DESIGN</b>	<b>L T P C 3 0 0 3</b>
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**UNIT I INTRODUCTION TO PROBABILITY THEORY 9**

Basic statistics – histograms – sample correlation – Random events and variables functions of random variables – moments and expectation – common probability distributions–extremal distributions.

**UNIT II RESISTANCE DISTRIBUTION AND PARAMETERS 9**

Statistics of properties of concrete – statistics of properties of steel – statistics of strength of bricks and mortar – dimensional variations – characterization of variables – allowable stress based on specified reliability.

**UNIT III STRUCTURAL RELIABILITY AND SAFETY 9**

Probabilistic analysis of loads, Gravity load, live load and wind load. Computation of reliability – Monte carlo method of structural safety – applications, Level 2 reliability methods – first order second moment methods (FOSM).

**UNIT IV RELIABILITY BASED DESIGN 9**

Determination of partial safety factors, code calibration, reliability of structural system; Applications to steel and concrete structures.

**UNIT V PERFORMANCE BASED DESIGN 9**

Concepts of Performance based design. Applications to Bridge structures – Longterm effects – Examples.

**TOTAL: 45 PERIODS**

**REFERENCES:**

1. Ranganathan. R, Reliability Analysis and Design of Structures, Tata McGraw – Hill publishing company limited, 1990.
2. Fabio Casciati, John Brian Roberts, Mathematical Models for Structural Reliability Analysis, Contributor: John Brian Roberts, CRC Press, 1996.
3. Qing Quan Liang, Quan Liang Qing, Performance-Based Optimization of Structures: Theory and Applications, Taylor & Francis, 2004.
4. Wai-Fah Chen, Lian Duan Bridge engineering handbook, CRC Press, 1999.
5. FEMA Documents FEMA-273 Seismic Rehabilitation Guidelines .
6. Milton E. Harr, Reliability – Based Design in Civil Engineering, Dover Publications Inc.,1997.
7. Madsent H.O. Krenk,. S., Lind N.C. methods of Structural safety, Dover Publications, 2003.

**FC9003****RESEARCH METHODOLOGY****L T P C**  
**3 0 0 3****UNIT – I:**

Scope, identification and selection of research problem – Experimental approach – Designing of Methodology – Planning and execution of investigation - Methods of editing and abstracting, Preparation of manuscript and proof reading – Thesis writing.

**UNIT – II:**

Acute and chronic toxicity test – Static renewal and Continue flow through methods. LC<sub>50</sub>, EC<sub>50</sub> determination using Probit and TSM analysis. FAV, CMC, CCC calculation. Water quality, nutrient analysis – major and minor ions.

**UNIT – III:**

Principles of Micro techniques – Fixatives and histological stains – fixation, tissue processing and staining- Freezing microtomy (Crystal). Electron Microscopy – SEM, TEM, STEM – principles and applications – Histological preparations of tissues for SEM & TEM.

**UNIT – IV:**

DNA sequencing and Human genome project, DNA fingerprinting and its application, DNA amplification and PCR, Gene and cDNA Library. Detection of genetic diseases using DNA recombinant technology.

**UNIT – V:**

Spectrophotometry – principle and applications – Colorimetry – visual UV – atomic absorption spectrophotometry – Flame Photometry. Chromatography – principles, types and applications – Paper, Column, Ion-exchange, HPLC, TLC, GLC. Electrophoresis: principles, types and applications – Paper, Agar gel, PAGE, SDS-PAGE, and Blotting techniques – Southern and western blotting techniques.

**REFERENCE BOOKS**

1. GURUMANI. N., (2006) Research Methodology for Biological Sciences, MJP Pub.
2. ABBAS.A.K., LICHTMAN.A.K., POBER.J.S. (1998) Cellular and molecular immunology, III Edition W.B. Saunders Company, U.S.A.
3. BENJAMIN LEWIN (1999) Genes VII. Oxford University Press, New York.
4. DESMOND.S.T., NICHOLL. (1994) An Introduction to genetic Engineering, Cambridge University Press, New York.
5. WALKER.C.H., HOPKIN. S.P., SIBLY. R.M., PEAKALL. D.B. (2001) – Second Edition- Principles of Ecotoxicology.

**FC9004****RANDOM VIBRATIONS****L T P C**  
**3 0 0 3****OBJECTIVE:**

To study the concept of random vibrations for dynamic analysis of structural systems subjected to stochastic loading like wind, earthquake and ocean waves.

**UNIT I FUNDAMENTALS OF LINEAR DYNAMICAL SYSTEM 9**

SDOF system, Free and forced vibration, Role of damping in vibration reduction, MDOF system and mode superposition.

**UNIT II PROBABILITY AND STATISTICS 9**

Introduction to probability, Bayes' theorem, Probability density function, Discrete and continuous stochastic variable, Conditional probability, Binomial, Normal, Poisson's distribution, Auto and cross correlation.

**UNIT III FOURIER ANALYSIS AND INTEGRAL 9**

Fourier analysis and transform, Forward and inverse transform, Properties of Fourier transform, Product in time domain as convolution in frequency domain and vice versa, FFT and its applications

**UNIT IV FREQUENCY DOMAIN ANALYSIS OF LINEAR DYNAMICAL SYSTEM TO RANDOM LOADING 9**

Narrow wind band random processes, Response to force define as power spectral density function, Mean squared response, FRF of typical dynamic system, Frequency response function versus Impulsive response function

**UNIT V APPLICATION OF RANDOM VIBRATION PRINCIPLES TO WIND, WAVE AND EARTHQUAKE LOADING 9**

Typical wind velocity spectra (Davenport, Kaimal etc.,) Aero dynamical and mechanical admittances, Mean wind – across wind – turbulence effects, Response computation of off-shore structures to wave loading , concept of response spectra in earthquake loading, Kanai – Tajimi spectra

**TOTAL: 45 PERIODS****REFERENCES:**

1. N.C. Nigam "Introduction to Random Vibrations", The MIT Press, 1983.
2. D.E. Newland 'An Introduction to Random Vibration and Spectral Analysis', Longman Group Limited, 1984
3. N.C. Nigam and S. Narayanan" Application of Random Vibration", Narosa Publishing house 1994.
4. Paul H.Wirsching, Thomas L, Paez, Keith Oritz "Random Vibrations : Theory and Practice", Dover Publications, 2006
5. Loren D.Lutes, Shahram Sarkani "Random vibration:Analysis of structural and mechanical systems" Elsevier Butterworth- Heinemann Publication, 2004
6. Christian Lalanne "Mechanical Vibration & Shock – Random Vibration Vol - III",Hermes Penton Science Publication, 2004

**COURSE OBJECTIVES:**

- Identify the carriers or vectors that promote the transfer of these agents from the environment to the human.
- Describe how these agents interact with biological systems, and the mechanisms by which they exert adverse health effects.
- Explain and use models for prediction of the magnitude of adverse effects in biological systems.

**UNIT I WATER TRANSPORT 9**

Water: types, sources and consequences of water pollution, Physico – chemical and Bacteriological sampling and analysis of water-Sewage waste water treatment and recycling. Water quality standards – Laying and maintenance, insitu lining – appurtenances.

**UNIT II WATER QUALITY MODELING 9**

Model – definition – types – uses-systems and models – kinds of mathematical models – model development-water quality standards –Historical development of water quality models – rivers and streams water quality modeling – river hydrology and flow –low flow analysis-dispersion and mixing-flow, depth and velocity.

**UNIT III SEWAGE DISPOSAL 9**

Ground water and the hydrologic cycles-Ground water as a resource –Ground water contamination-Sources of contamination-Land disposal of solid wastes-Sewage disposal on Land. Ground water and geologic processes.

**UNIT IV HEALTH IMPACT ASSESSMENT 9**

Water pollution effect on health-Sampling methods-Purpose of sampling, different types of samples, collection methods-Methods involved in estimation of parameter for pollution levels – Water pollution control strategies-Importance of waste water disposal for diseases control – Role of water in the transmission and prevention of infections-Methods used during routine surveillance and monitoring-Exposure pathways and human responses to hazardous and toxic substances.

**UNIT V WATER BORNE DISEASES 9**

The microbiological social and public aspects of sanitation and water supply, the micro-organisms responsible for disease, their origins, mechanisms for elimination, and the epidemiology of waterborne and water washed disease.

**TOTAL=45 PERIODS**

**REFERENCES:**

1. Environmental and Health and Safety Management by Nicholas P.Cheremisinoff and Madelyn L.Graffia, William Andrew Inc. NY, 1995.
2. Ground water Hydraulics and Pollutant transport by Randall J.Charbeneau, "Prentice Hall, Upper Saddle River, 1999.
3. Water Management Models – A Guide to Software by Ralph A.Wurbs Prentice Hall PTR, New Jersey, 1995.
4. Water pollution by Sharma B.K.,Goel Publishing house, Meeruth, 2001.
5. Water Borne disease Epidemiology and Ecology by Paul R Hunter, John Wiley & Sons Ltd., 1997.
6. Health and Environmental Risk Analysis fundamentals with application by Joseph F Louvar and B Diane Louvar Prentice Hall, New Jersey, 1997.

**OBJECTIVE:**

- To impart knowledge in Concepts in Meteorology, Radio, and Satellite Meteorology and its Applications

**UNIT I GENERAL CONCEPTS IN METEOROLOGY 9**

Weather and Climate- composition of atmosphere- temperature and pressure Distribution- Winds over the earth`s atmosphere- scales of atmospheric processes Land/Ocean Coupling- Indian monsoons- other major weather systems of seasons- Brief introduction to Indian Climatology. Radiation transfer- radiation spectrum – Absorption and emission of radiation by molecules- Radiation laws- scattering principles. Cloud physics- Mechanism of cloud formation- Types of Clouds- Precipitation processes- warm and cloud concepts and processes

**UNIT II RADIO METEOROLOGY 9**

Principles and classifications of Radar- components of Radar- Meteorological Applications. Upper air temperature exploration of the atmosphere(Radio Sonde)-Upper air wind estimation through pilot balloon- Wind estimation through Radar ( Rawin Sonde) , Doppler technique Precipitation estimation through Radar and problems associated with it – Precipitation Radar ( PR ) on-board satellites such as Tropical Rainfall Measuring Mission ( TRMM ), Global Precipitation Measurement ( GPM ), Ozone soundings – general principle and special satellite measurements of ozone – Aerosol soundings Tracking of weather systems such as Thunderstorms, Tropical cyclones, Tornadoes through Radar – Structure of weather systems as observed by Radars –Hydro meteorological Applications of Radar. Applications to aviation meteorology

**UNIT III INTRODUCTION TO SATELLITE METEOROLOGY 9**

Orbital dynamics of satellite – Critical velocities – Polar and Geostationary weather satellites. Active and passive sensors ( Radar/ Lidar /Radiometers)- Absorption bands of atmospheric gases. Design and characteristic of different types of sounders and imagers used in Meteorological satellites – Viewing geometry. INSAT Meteorology. Data Processing System ( IMDPS ), IRS series – High Resolution Picture Transmission – APT – AVHRR. Need for Remote Sensing techniques in weather forecasting and Numerical Weather Prediction ( NWP )

**UNIT IV METEOROLOGICAL APPLICATIONS 9**

Precipitation – Outgoing Longwave Radiation (OLR) and Sea Surface Temperature (SST) estimation and their Applications – Normalised Difference Vegetation Index – Ocean Colour monitoring – Coastal pollution. Image Interpretation. Satellite communication systems in operational meteorological Applications (Cyclone Warning Dissemination system / Automatic Weather stations – Meteorological data dissemination). Estimation of snow and ice cover – Waterbody boundary mapping – Atmospheric aerosols – Dust storms – Volcanic ash clouds and fires.

**UNIT V APPLICATIONS TO STORM SURGE 9**

Identification – Tracking of weather systems – Derivation of cloud motion vector Dvorak's technique of cyclone intensity estimation – T number and current intensity No. – Applications to storm surge estimation. Satellite soundings – TIROS Operational and Vertical sounder – Retrieval methods and algorithms

**TOTAL: 45 PERIODS**







## UNIT IV TRIP DISTRIBUTION MODELLING

10

Definitions and notation - Growth – factor methods - Uniform growth factor - Singly constrained growth – factor methods - Doubly constrained growth factors - Advantages and limitations of growth – factor methods - Synthetic or gravity models - The gravity distribution model - Singly and doubly constrained models - The entropy – maximizing approach - Entropy and model generation - Generation of the gravity model - Properties of the gravity model - Calibration of gravity models - Calibration and validation - Calibration techniques.

## UNIT V THE LAND USE TRANSPORT MODEL

9

Partial and general models – The general structure of the Lowry model – The economic base mechanism – The location of activities – The integration of the economic base and allocation mechanisms – Problems and limitations – Discrete choice model theoretical framework - The multinomial logit model(MNL) - Specification searches - Some properties of the MNL - The hierarchical logit model (HL) - Correlation and model structure - The HL in practice - Other choice models - The multinomial probit model - Choice by elimination and satisfaction - Habit and hysteresis.

### REFERENCES:

1. Integrated Land-Use and Transportation Models Behavioural Foundations. Martin Lee-Gosselin (Universite Laval, Quebec, Canada), Sean Doherty, Publication date: 01 Jul 2005 Imprint: Elsevier Science Ltd SBN: 9780080446691
2. The Geography of Transport Systems By Jean-Paul Rodrigue, Claude Comtois, Brian Slack. Published May 18th 2009 by Routledge – 352 pages
3. Ortuzar Juan de Dios / Willumsen Luis G “*Modelling Transport*”, 4th Edition March 2011. 606 pages Hardcover – Textbook – ISBN -10:0-470-76039-7.
4. Colin Lee (1973); Urban and Regional Planning series, Volume 4. *Model in Planning – An Introduction to the use of quantitative models in planning*
5. Alonso, W. (1964) *Location and Land use* Harvard University Press, Cambridge.
6. Anas, A. (1982) *Residential Location Markets and Urban Transportation*. Academic Press, London.
7. Hensher, D.A. and Johnson, L.W. (1981) *Applied Discrete choice modeling*. Croom Helm, London
8. Johnson, L.W. (1990) “*Discrete choice analysis with ordered alternatives*”. In M.M. Fisher P. Nijkamp and Y.Y. Papageorgiou (eds.), *Spatial choice and processes*. North Holland, Amsterdam.
9. Wills, M.J. (1986) *A flexible gravity – opportunities model for trip distribution*. Transportation Research, 20B (2), 89-111.

