ANNA UNIVERSITY: : CHENNAI - 25

FACULTY OF CIVIL ENGINEERING

Approved Special Electives for

M.S. / Ph.D. Degree Programs

(upto 25th AC 02.05.2019)

ANNA UNIVERSITY :: CHENNAI – 600 025.

SPECIAL ELECTIVES FOR FACULTY OF CIVIL ENGINEERING

COURSE CODE	COURSE TITLE	L	T	P	M/C
SCE002	Corrosion Engineering (Code Revised on 02.05.2019)	3	0	0	3
FC1911	Networking Technology And Social Aspects In Rural Water Supply	3	0	0	100
FC1912	Exploration in Heuristic And Optimal Decisions	3	0	0	100
FC1913	Public Transportation	3	0	0	100
FC1914	Bus Transport Management	3	0	0	100
CZ040	Climate Change Mitigation And Adaptation	3	0	0	3
FC9001	Environmental Nanotechnology	3	0	0	3
FC9002	Reliability Analysis And Performance Based Design	3	0	0	3
FC9003	Research Methodology	3	0	0	3
FC9004	Random Vibrations	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
FC9009	Instrumentation In Geotechnical Engineering	3	0	0	3
FC9010	Concretes and Repair Techniques	3	0	0	3
FC 9011	Pavement Materials	3	0	0	3
FC9012	Climate Change and Climate Modelling	3	0	0	3
FC9013	Wind Energy Noise Mitigation	3	0	0	3
FC9014	Energy Economics	3	0	0	3
SCE001	Applications of Nanomaterials in Civil Engineering	3	0	0	3
FC9015	Constitutive Modelling in Geomechanics	3	0	0	3

SCE002 **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 . Austentic 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, Addision 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, Mc- Graw Hill Book Company, 1976.
3. Taha H.A. Operations Research – An Introduction, Prentice Hall of India Pvt. Ltd., New Delhi, 6th 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:

1. Ruddiman. W.F., Earth's Climate: Past and Future, W.H. Freeman and Company, 2001.
2. Houghton. J.T., et al., (eds.), Climate Change 2001: The Scientific Basis, Cambridge University Press, Cambridge, U.K. 2001.
3. 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 abalation, 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_2 storage.

UNIT V ENVIRONMENTAL APPLICATIONS 10

Gas sensors, microfludics 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 Verlsh 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.

FC9002 RELIABILITY ANALYSIS AND PERFORMANCE BASED DESIGN **L T P C 3 0 0 3**

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: Theyory and Appplications, 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 d 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_{50}, EC_{50} 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 stuctural and mechanical systems"' Elsevier Butterworth- Heinemann Publication, 2004
6. Christian Lalanne "Mechnical Vibration & Shock – Random Vibration Vol - III",Hermes Penton Science Publication, 2004

FC9005	WATER POLLUTION AND ITS HEALTH IMPACT ASSESSMENT	L T P C 3 0 0 3

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.

FC9006 GEOMATICS IN METEOROLOGY L T P C
3 0 0 3

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- MeteorologicalApplications. 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

REFERENCES:

1. Kidder and VonderHarr, “Satellite Meteorology: An introduction”, 1995, Academic Press, San Diego, CA
2. Cracknell, “The Advanced Very High Resolution Radiometer (AVHRR)”, 1997, Taylor and Francis Int. Ltd., Great Britain.
3. Smith and Schreiner, “Advances in Remote Sensing”, Deppak Publications
4. Asnani, G.C “Tropical Meteorology”, Vol. I and II, 1993
5. Doviak and Zrnic, “Doppler Radar and Weather observations”, 1992, Academic press, London.
6. Ellingson, “Satellite Data Applications: Weather and Climate”,Proc.Of AO I Symp., COSPAR, Birmingham, UK, Elsevier, MD, USA
7. Sauvageot, 1992, “Radar Meteorology”, Artech House Publishers, Norwood, MA.

FC9007	**HUMAN FACTORS IN ROAD ACCIDENT OCCURENCE**	**L T P C**
		3 0 0 3

OBJECTIVES:

- Helps in identifying the reasons for road accidents and scientific Investigation.
- Helps to improve the present accident situations in highway and transport sectors.

UNIT I CAUSES OF ACCIDENTS 9

Road accidents data -Causes of road accidents – Four important factors - Human, Road, Vehicle and environment – Vehicles and Bus Accidents– Accident rates-Prevention methods.

UNIT II HUMAN FACTORS 9

Concept of Man and Machine System – Human Behavior – Influencing Factors – Physical And Psychological Factors – Reaction time value for drivers responding to various accident situations – Standard reaction time- Ergonomics – Driving and accident- Human functional failures- Critical driving situations - Socio-Economic Factors.

UNIT III LICENSING PRACTICES 9

Indian Practices – Practices in Other Countries – Driver Training for light and heavy vehicles– Age, Qualification, Physical fitness etc., - Syllabus for driver training- Cancellation and Renewal of Licenses- Modern trends in Licensing- Smart card.

UNIT IV STATISTICAL ANALYSIS 9

Chi-square Test – Before and after Studies – Accident Prediction Models – Empirical Bayees Approach – Regression to Mean.

UNIT V TOOLS AND TECHNIQUES TO STUDY HUMAN FACTORS 9

Reaction Tester – Eye Tester – Driving Simulator – Various testing and training methods in simulators-RFID Technique for Driving Test – Interview Techniques and Analysis

TOTAL: 45 PERIODS

REFERENCES:

1. Khanna S.K. and Justo C.E.G, Highway Engineering, Nem Chand and Brothers, Roorkee, 2001
2. Robert F. Baker, Hand Book of Highway Engineering, Van Nonstrant Keinhold Company, New York, 1975
3. TRACE WP5 Summary Report, Analyzing Human Factors in Road Accidents- February 2007
4. Advanced Motoring, Institute of Advanced Motorists Manual, 3rd Edition 2003
5. Robert E. Dewar PhD and Paul L.OlsonPhD., Human Factors in Traffic Safety, second edition 2007.

FC9008 LAND USE TRANSPORTATION MODELLING L T P C
3 0 0 3

OBJECTIVE:

- To study the interaction between the Land use and the travel pattern in cities and its entailment on the process of the strategic policy decision making.

UNIT I LAND USE TRANSPORATION PLANNING AND MODELLING 7

The spatial location of population and employment and its implications on its spatial interactions – The related Land use Transport Models and their role - Characteristics of transport problems - Characteristics of transport demand - Characteristics of transport supply - Equilibration of supply and demand.

UNIT II MODELLING AND DECISION MAKING 9

Decision – making styles - Choosing modelling approaches - Issues in transport modeling - General modeling issues - Aggregate and disaggregate modeling - Cross – section and time series - Revealed and stated preferences - The structure of the classic transport model - Continuous transport planning - Theoretical basis versus expedience.

UNIT III TRIP GENERATION MODELLING 10

Introduction - Some basic definitions - Classification of trips - Factors affecting trip generation - Growth – factor modeling - Regression analysis - The linear regression model - Zonal – based multiple regression - Household – based regression - The problem of non – linearities - Obtaining zonal totals - Matching generations and attractions - Cross – classification or category analysis - The classical model - Improvements to the basic model - The person – category approach - Forecasting variables in trip generation analysis - Stability and updating of trip generation parameters - Temporal stability - Geographic stability - Bayesian updating of trip generation parameters - Inelasticity of trip generation.

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 multinominal 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 multinominal 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.

FC9009 INSTRUMENTATION IN GEOTECHNICAL ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

This course introduces concepts, technologies, procedures and applications of instrumentation in Geotechnical Engineering.

UNIT I BASICS OF INSTRUMENTATION

Introduction - Instrument systems-Mechanic- Hydraulic- Pneumatic and Electric, Electronic, Magnetic and Electro Magnetic type of instrument and measurements of load, pore water pressure, earth pressure, ground movement strain and Temperature.

UNIT II STATIC MEASUREMENTS

Static load application methods with reference to model testing Transducers and Instrumentation for Measurement of Force, Pressure, Strain, Displacement, Data Acquisition Systems.

UNIT III VIBRATION MEASUREMENTS

Characteristics of Vibrations- - Transducers for velocity and acceleration measurements. Vibration meter-Sensors- Seismographs- Vibration Analyzer- Display and recording of signals.

UNIT IV FIELD INSTRUMENTATION

Reason- Selection of Instruments-Applications-- design of instrumentation pattern for monitoring during and after construction – Installation of instruments to measure ground motions- Pore-water pressure Earth pressure cells-Pressure cells –calibration and monitoring-interpretation of results-Case studies.

UNIT V NON DESTRUCTIVE TESTING METHODS

Load testing on Foundation elements- Pile load test-Pile quality assurance-PDA-PIT-GRLWEAP-CAPWAP-PIR-ESAX-CHA-SPT-ACT -GPR-Testing and Interpretations-Case studies.

TOTAL: 45 PERIODS

REFERENCES

1. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 1996.
2. Thomas H.Hanna, “Field instrumentation in geotechnical engineering”, Trans Tech Publications, Switzerland, 2005.
3. K.RSaxena and V.M Sharma, “Instrumentation in Geotechnical Engineering”, Oxford & IBH Publishing Company, 2001.
4. Edward J.Cording, “Methods for geotechnical observations and instrumentation in tunneling, Volume 1”, National Science Foundation, 1975.

FC9010 CONCRETES AND REPAIR TECHNIQUES L T P C
3 0 0 3

UNIT I CONCRETE TECHNOLOGY 10

Cements – Grade of cements - manufacture of cement – concrete chemicals and Applications –Mix design concept – mix design as per BIS & ACI methods – manufacturing of concrete –Batching – mixing – transporting – placing – compaction of concrete – curing and finishing.-Testing of fresh and hardened concrete – quality of concrete - Non destructive testing.

UNIT II SPECIAL CONCRETES 9

Concrete chemicals, special elements for accelerated strength gain, Expansive cement, Bacterial concrete - Born again concrete (Recycled Aggregate concrete)-Electric concrete (Smart concrete) – Light weight concrete-Foam concrete-Fibre reinforced concrete - applications.

UNIT III MAINTENANCE AND REPAIR STRATEGIES 8

Demolition techniques for structures-Maintenance, repair and rehabilitation, Facets of Maintenance, importance of maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

UNIT IV REHABILITATION TECHNIQUES 9

Rust eliminators and polymers coating for rebars during repair, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, Mud jacking grout through slab foundation - micropiling for strengthening floor and shallow profile - pipeline laying - underpinning, crack stabilization techniques.

UNIT V STRENGTHENING AND PROTECTION OF STRUCTURES 9

Strengthening of structures distressed due to earthquake – Strengthening using FRP- Strengthening and stabilization techniques for repair. .Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings and cathodic protection.

TOTAL: 45 PERIODS

REFERENCES:

1. Santhakumar.A.R., Concrete Technology,Oxford University Press,New Delhi.2007.
2. Neville,A.M.,Properties of concrete,Longman,1995.
3. M.S.Shetty. “Concrete Technology” S.Chand and Company Limited,Delhi,2000
4. Peter H.Emmons, “Concrete Repair and Maintenance Illustrated”,Galgotia Publications pvt.Ltd.,2001
5. Sankar,S.K.and Saraswati,S.,Construction Technology,Oxford University Press,New Delhi,2008.

Faculty of Civil Engineering **(Approved in 18th AC (Ad hoc) 09.08.2014)** **ITEM NO. FC 18.03 (3)**

FC 9011 PAVEMENT MATERIALS L T P C

3 0 0 3

UNIT I BASIC CONCEPTS 9

Introduction- Sub grade soil - Soil composition and structure - Soil classification for engineering purposes- Origin, Classification, requirements, properties and tests on road aggregates

UNIT II BITUMINOUS MATERIALS 9

Origin, preparation, properties and tests, constitution of bituminous road binders, requirements - Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests.

UNIT III FLEXIBLE PAVEMENT 9

Factors affecting flexible pavement – Material Characterization for analytical pavement design- CBR and Stabilometer test- Resilient modulus – Fatigue system – Failure criteria for bituminous pavements – IRC Design guidelines.

UNIT IV POLYMERIC MATERIALS 9

Characterization of polymeric materials – Thermoplastics – Effect of temperature on polymeric materials used for the construction – Issues involved.

UNIT V STABILISATION OF SOIL FOR ROAD CONSTRUCTIONS 9

The need for a stabilized soil – Design criteria and choice of stabilizers- Testing and field control- Stabilization of rural roads- Use of geo fabrics in road construction- Case studies.

TOTAL: 45 PERIODS

REFERENCE BOOKS:

1. Wright, P.H., Highway Engineers, Johwiley& Sons, Inc. New York, 2009.
2. Yoder, R.J and Witchak, M.W., Principles of Pavement Design, John wiley, 2000.
3. Khanna, S.K and Justo C.E.G., Highway Engineering, New Chand and Brothers, Roorkee, 2010.
4. Guidelines for the Design of Flexible Pavements, IRC: 37 – 2001, The Indian Roads Congress, New Delhi.
5. Principles and Practice of Highway Engieering by L.R. Kadiyali, Khanna Publishers, 2010.
6. A.I. Al-Hadidy, Tan Yi-qiu, Mechanistic approach for polypropylene-modified flexible pavements, Materials & Design, Volume 30, Issue 4, April 2009, Pages 1133-1140, ISSN 0261-3069, 10.1016/j.matdes.2008.06.021.
7. Suo Zhi, Wong Wing Gun, Luo Xiao Hui, Tian Bo, Evaluation of fatigue crack behavior in asphalt concrete pavements with different polymer modifiers, Construction and Building Materials, Volume 27, Issue 1, February 2012, Pages 117-125, ISSN 0950-0618, 10.1016/j.conbuildmat.2011.08.017.

Faculty of Civil Engineering **(Approved in 18th AC (Ad hoc) 09.08.2014)** **ITEM NO. FC 18.03 (4)**

FC 9012 CLIMATE CHANGE AND CLIMATE MODELLING L T P C
3 0 0 3

OBJECTIVE:

- To introduce the emerging concepts of climate modeling and projecting future climate change, understand data analysis and application.

UNIT I CLIMATE CHANGE AND CLIMATE VARIABILITY 9

Introduction – Atmosphere - weather and Climate - climate parameters (Temperature ,Rainfall, Humidity, Wind etc) – Equations governing the atmosphere - Numerical Weather Prediction Models - Introduction to GCMs - Application in Climate Change Projections.

UNIT II IPCC SRES SCENARIOS 9

Intergovernmental Panel on Climate Change (IPCC) - An Overview - Key Assumptions - Scenario Family - Storyline (A1, B1, A2, B2).

UNIT III GLOBAL CLIMATE MODEL (GCM) AND REGIONAL CLIMATE MODEL (RCM) 9

Some typical GCMs (HadCM3Q-UK Met Office) - Issues with GCMs - Introduction to RCMs and LAMs - some typical RCMs like PRECIS, SimCLIM, MAGICC/SCENGENE - Advantages and Disadvantages of GCMs and RCMs.

UNIT IV DOWNSCALING GLOBAL CLIMATE MODEL - AN OVERVIEW 9

Need for downscaling - Selection of GCMs for regional climate change studies - Ensemble theory – Selection of - Ensembles, Model Domain (Spatial domain and temporal domain), Resolution and climate variables - Lateral boundary conditions - Methods of downscaling (Statistical and Dynamical) - examples from each and their limitations.

UNIT V ANALYSIS /POST PROCESSING 9

Model Evaluation - post processing – Introduction to Analysis tools - Ferret, R, Grads, IDL, SPSS, ArcGIS - Climate change Impact - Vulnerability studies.

TOTAL: 45 PERIODS

REFERENCES:

1. IPCC Fourth Assessment Report, Cambridge University Press, Cambridge, UK.
2. McGuffie, K. and Henderson-Sellers, A. (2005) “A Climate Modelling Primer, Third Edition, John Wiley & Sons, Ltd, Chichester, UK.
3. Neelin David J, “Climate Change and Climate Modelling”, Cambridge University Press
4. Thomas Stocker, “Introduction to Climate Modelling”, Advances in Geophysical and Environmanetal Mechanics and Mathematics. Springer Publication.

FC 9013 WIND ENERGY NOISE MITIGATION L T P C
3 0 0 3

OBJECTIVES:

- To understand the wind energy fundamentals &Wind Measurements
- To understand the fundamentals of noise and noise measurement techniques
- To model and analysis the Noise data from wind turbine

UNIT I WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS 9

Wind Turbine Technology-Evolution of Wind Turbine Technology-Development of Modern Technology-Types of Wind Turbines-Wind Turbine Structure-Operation of Wind Turbines-Wind Energy Programme-Wind Power Installation in Global and India-Wind Power Generation in Global and India-Emission Reduction in India- Environmental Benefits and Impacts in Wind Turbines – Metrological effects-Wind Speeds and scales, Wind speed gradient, Temperature gradient, Air absorption, Terrain, Roughness, Atmospheric Boundary Layers, Turbulence.

UNIT II NOISE 9

Sound and decibels, basic math and weighting's sound power and sound pressure (A, C, etc.) – sound levels and human hearing – human response to noise – industrial and transportation sources of noise – sound propagation –– basics of noise from wind turbines - Control methods and reduction strategies for noise.

UNIT III ACOUSTIC NOISE MEASUREMENT TECHNIQUES 9

Instrumentation-acoustic instruments, non – acoustic instruments, traceable calibration, Measurements and measurements procedures – measurement positions, acoustic measurements, non-acoustic measurements, data reduction procedures – wind speed, correction for background noise, apparent sound power levels, one-third octave band levels, tonality, directivity.

UNIT IV MODELING AND ANALYSIS OF DATA 9

Statistical methods – statistical representation of data modeling and analysis of data - modeling parameters – data manipulation and data presentation – regression methods – linear and non–linear regression –Windpro Software–ISO 9613-2 "Acoustics- Attenuation of sound during Propagation of Outdoors"

UNIT V STANDARDS AND ENVIRONMENTAL POLICIES 9

International Standard-IEC 61400-11, Introduction to environment Policies – general principles - guidelines and acceptable limits, Environment (Protection)Act 1986 , Air (P&CP) Act 1981, National Ambient Air quality Standards with respect to noise, Noise criteria (regulatory approaches for various sources)

TOTAL: 45 PERIODS

OUTCOMES

- Understand the fundamentals and measurements of wind energy.
- Able to model and analysis the noise data from wind turbine.

REFERENCES:

1. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press, 1994.
2. Global Wind Report "GWEC-2012", Global Wind Energy Council, Belgium, 2012.
3. S.Wagner,R.Bareiss, G.Guidati, Wind Turbine Noise. Springer Verlag,1996
4. International Standard IEC 61400 – 11 Second edition 2002-12 Wind turbine generator systems – Part 11 : Acoustic noise measurement techniques (2002-2012)
5. Sreevalsan E. Siddarth Shankar Das, Sasi Kumar R. and Arivukkodi G. "Indian Wind Atlas" (2010). Centre for Wind Energy Technology, 2010.
6. WindPRO Software Catalogue. (could be downloaded from www.emd.dk), EMD, Denmark.
7. CPCB "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
8. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996.
9. Daniel Vallero "Fundamentals of Air Pollution", 4th Ed., Academic Press Elsevier, Newyork, 2008.

FC9014 ENERGY ECONOMICS L T P C
3 0 0 3

AIM:

- To inculcate knowledge about the energy market, economic factors involved energy planning and energy - economy - environment interaction.

OBJECTIVES:

- To explore basic concepts of economics and planning of energy systems.
- To provide students with relevant techniques needed for techno-economic analysis, planning and execution of energy projects.

UNIT I INTRODUCTION 9

Energy Scenario - India and World - Role of Energy in Economic Development - Basics of Energy - Sources of Energy – Conventional and Renewable – Engineering Economics - Social Cost Benefit Analysis.

UNIT II ENERGY FORECASTING 9

Energy Econometrics and Statistical Analysis – Regression models – Econometric techniques for Energy Analysis and Forecasting - Double Moving Average - Double & Triple Exponential Smoothing - Delphi Technique.

UNIT III ENERGY ANALYSIS 9

Energy Indices - Methods of Energy Analysis - Demand - Supply Balancing - Demand Side Management - Energy Models - Energy Pricing - Energy - Economy - Environment Interaction.

UNIT IV ENERGY POLICY 9

India's Energy Policy - Electricity Act - Energy Conservation Act - Renewable Energy Certificate - Renewable Purchase Obligation - PAT scheme - National Action Plan on Climate Change - National Solar Mission - Carbon Credits - Clean Development Mechanism.

UNIT V PROJECT MANAGEMENT 9

Energy Management Information System - CUSUM Technique - Energy Projects Evaluation - Funds Planning - Financing Options - Project Implementation and Monitoring Techniques - ESCO Models / Types.

TOTAL: 45 PERIODS

OUTCOME:

- Students will be able to comprehend theories, skills and techniques needed for energy analysis, policy planning, econometric analysis and execution of energy related projects.

REFERENCES:

1. Mohan Munasinghe and Peter Meier, 1993, Energy Policy analysis and Modeling: Cambridge University Press.
2. Harry F Campbell and Richard P C Brown, 2003, Benefit- Cost Analysis, University of Queensland Press.
3. I. Bousted and G.F. Hancock, 1979, Handbook of Industrial Energy Analysis.
4. A.G. Thomas, 1977, Energy Analysis, IPC Science and Technology Press Ltd.
5. Chan S. Park, 2002, Contemporary Engineering Economics, Prentice Hall Inc.
6. Maxime Kleinpeter, Energy Planning and Policy, John Wiley & Sons (1995)

SCE001 APPLICATIONS OF NANOMATERIALS IN CIVIL ENGINEERING L T P C
3 0 0 3

UNIT I NANOMATERIALS IN CONCRETE 9

Global cement production – Role of TiO2 – Properties and technological advantages of nanomaterials – Carbon Nano-Tubes (CNT): Structure, Properties and Applications in concrete – Durability-Hydrophilicity – Hydrophobicity – Self compacting concrete – Mix design-Properties – Alternate materials to concrete.

UNIT II NANO STEEL 9

Structural steel – New alloy steels – Characteristics of nano steel – Fatigue on nano steel – High strength cables – High strength bolts-nano coatings – Properties – Behaviour of welded joints.

UNIT III NANO COMPOSITES 9

Introduction to composites – Various types of macro composites and importance – Properties – Polymer nanocomposites – Potential applications of nanocomposites – Case studies.

UNIT IV DAMAGE IN HYDRAULIC STRUCTURES 9

Types of damage and distress – causes – assessment – evaluation – damage assessment of structures with case studies – Physiochemical characterization of nano particles in aquatic medicollaid chemistry.

UNIT V SUSTAINABILITY AND ENVIRONMENT 9

Environmental monitoring and sensing – Air monitoring – Water monitoring – Environmental impacts and application of nano materials – Mechanisms of reactive oxygen species (ROS) production by nanomaterials – Nanomaterials for environmental remediation and water treatment – Assessment of nanoparticle Toxicity – Good laboratory practices-protective measures.

TOTAL: 45 PERIODS

REFERENCES

1. Wilson M, Kannangara.K, Smith G, Simmons M and Raguse B.M.,“Nanotechnology:Basic Science and Emerging Technologies”, Chapman and Hall/CRC 2005.
2. Charles P. Poole and Frank J. Owens, “Introduction of Nanotechnology”, John Wiley an Sons, 2003.
3. Mark Ratner and Daniel Ratner, “Nanotechnology: A Gentle Introduction to the Next Big Idea”, Prentice Hall PTR, 2003.
4. Thomas E. Twardowski, “Introduction to Nanocomposite Materials: Properties, Processing Characterization” DES Tech Publications Inc.,2007.
5. Sam Zhang and Nasar Ali, “Nanocomposite Thin Films and Coatings: Processing, Properties and Performance,” Imperial College Press, 2007.

FC9015 CONSTITUTIVE MODELLING IN GEOMECHANICS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various constitutive models proposed by several researchers to describe various aspects of soil behavior in detail and also to apply such models in soil modelling for geotechnical engineering applications.

UNIT I BOUNDARY VALUE PROBLEMS IN CONTINUUM MECHANICS 10

Mechanics- Complexities of the mechanical behavior of soils- Tensorial form of constitutive relationship –Principle of stresses-stress tensor- equations of motions-principal stress- stress tensor invariants-octahedral stresses- strain tensors –geometric interpretation –Compatibility equations- equations of continuum mechanics – Examples of boundary value problem formulation.

UNIT II CONSTITUTIVE MODELLING OF REVERSIBLE SOIL BEHAVIOR 08

Modulus of soil – Measurement of modulus- small strain stiffness – Estimation of modulus from other properties- Hyperbolic Ducan- Chang model- Bilinear piece wise elastic model- Incremental model – Multilinear model – Ramberg- Osgood function- Logarithmic function – masing rules- modeling cyclic and dynamic small strain behavior- Comparison between non –linear models- The theoretical framework.

UNIT III CONSTITUTIVE MODELLING OF IRREVERSIBLE SOIL BEHAVIOR 12

Failure – Visualization of failure surface- Haigh- Westergard stress space- Interpretation of various shear tests in octahedral plane, Mohr Columb- Drucker Prager failure criteration- Plastic loading and consistency condition- Hardening rule- Associated flow rule- Stability postulate- Dilatancy- plastic potential- incremental elastic –plastic stress strain response- General stress space-dilatancy- plastic potential and non associated flow rule- Angle of dilation- Asymmetry of stiffness matrix- Incremental response in general stress space- critical state- original cam- clay- formulation and behavior – modified cam clay model- irreversibility in cyclic behavior- rate and time dependent behavior.

UNIT IV ADVANCED CONSTITUTIVE MODELS 09

Boundary Surface plasticity model(BSP) , Ghauboussi‘s model , Infinite number of surface (INS) model, Nova‘s model, Prevost’s model , RS model, Zaretsky‘s model, Lade’s Model , Isotropic hardening double surface Plasticity model, Viscoplastic models- Perzyna’s formulation, Hierarchical single Surface (HISS) models, Incremental constitutive relation for soils. Barodesy- the next generation hypoplastic constitutive model for soils.

UNIT V DISTURBED STATE CONCEPT 06

Introduction – Engineering behavior, Mechanism- Fully Adjusted state (FAS),Additional considerations, Characteristic dimension, Observed Behavior, The formulation of the disturbed state concept, Incremental Equations- Relative Intact state, Fully Adjusted state, Effective or Net stress, Alternative formulations of the DSC – Material element composed of two materials.

TOTAL : 45 PERIODS

OUTCOMES:

- Students are able to achieve a basic understanding of conventional continuum mechanics approaches to constitutive modelling, which can serve as a foundation for exploring more advanced theories. The advantages, disadvantages and limitations of modelling different aspects of complex soil behavior using constitutive models is understood.

TEXTBOOKS:

1. Alexander.M.Purzin , “Constitutive modelling in Geomechanics”, Springer Verlag Berlin Heidelberg., 2012.
2. Chandrakant S. Desai., “Application of Finite Element and Constitutive Models”- Solid structure and soil structure interaction.” Notes for short term course, Tucson, AZ, USA,2012
3. D. Kolymbas, G. Hofstetter (ed.), “Computational Engineering”, Springer International Publishing Switzerland 2014
4. Morz,Z and Norris,V.A ., “ Elastoplastic and Viscoplastic Constitutive models for soils with application to cyclic loading”. ‘’Soil Mechanics- Transient and cyclic Loads, ed. G.N Pande and O.C. Zienkiewicz, Wiley., 1982. 173-218
5. Chandrakanth .S. Desai , “Mechanics of materials and Interfaces – The disturbed state concept ”, CRC Press LLC., Florida, U.S.A 2001.

REFERENCES:

1. Wood, D.M., "Soil behavior and Critical State Soil Mechanics", Cambridge University Press, New York, 1990.
2. Robert D. Holtz., William D. Kovacs., Thomas C. Sheahan., “An Introduction to Geotechnical Engineering” Dorling Kindersley India pvt. Ltd., Second edition, 2013.
3. Jean-Louis Briaud., “Geotechnical Engineering: Unsaturated and Saturated Soils”-John Wiley and sons, New Jersy, 2013.
4. Mike Jefferies, Ken Been., “Soil Liquefaction –A Critical state approach”- Second edition-CRC Press – Taylor and Francis group., 2016