UNIVERSITY OF CALICUT

SCHEME AND SYLLABI

of

M.TECH

in

WATER RESOURCES AND HYDROINFORMATICS

(CIVIL ENGINEERING)

Scheme and Syllabi for M.Tech Programme in Water Resources and Hydroinformatics

SEMESTER 1

Sl no	Course code	Subject	Hours/ week			ICA	ESE	Total	Credits
			L	T	P				
1	CEH10 101	Applied Statistics	3	1	0	100	100	200	4
2	CEH10 102	Advanced Surveying and Remote Sensing	3	1	0	100	100	200	4
3	CEH10 103	Water Resources System Engineering	3	1	0	100	100	200	4
4	CEH10 104	Advanced Free Surface Flow	3	1	0	100	100	200	4
5	CEH10 105	Elective I	3	1	0	100	100	200	4
6	CEH10 106(P)	Seminar	0	0	2	100		100	2
7	CEH10 107(P)	Advanced Survey & Hydrology Lab	0	0	2	100		100	2
8	-	Departmental Assistance	-	-	6	-	-	-	-
Total			15	5	10	700	500	1200	24

ELECTIVE I

CEH10 105A	Watershed Conservation and Management
CEH10 105B	Information Technology for GIS data management
CEH10 105C	Optimisation Techniques
CEH10 105D	Physiochemical Processes for Water And Wastewater Treatment

L-Lecture T-Tutorial P-Practical ESE-End Semester Examination
ICA-Internal Continuous Evaluation

SEMESTER 2

Sl no	Course code	Subject	Hours / week			ICA	ESE	Total	Credits
			L	T	P				
1	CEH10 201	GIS and Hydroinformatics	3	1	0	100	100	200	4
2	CEH10 202	Advanced Hydrology and Water Resources Engineering	3	1	0	100	100	200	4
3	CEH10 203	Environmental Impact Assessment	3	1	0	100	100	200	4
4	CEH10 204	Elective II	3	1	0	100	100	200	4
5	CEH10 205	Elective III	3	1	0	100	100	200	4
6	CEH10 206(P)	Seminar	0	0	2	100		100	2
7	CEH10 207(P)	GIS Lab	0	0	2	100		100	2
	-	Departmental Assistance	-	-	6				
		TOTAL	15	5	10	700	500	1200	24

Elective II

CEH10 204A	Water Pollution Control and Stream Sanitation
CEH10 204B	Management Information Systems
CEH10 204C	Fluvial Hydraulics
CEH10 204D	Biological methods in Environmental Engineering
CEH10 204E	Data Acquisition in Hydroinformatics

Elective III

CEH10 205A	Hydrologic Analysis and Design
CEH10 205B	Groundwater Contamination and Pollution Transport
CEH10 205C	Environmental Geology
CEH10 205D	Water Power Engineering
CEH10 205E	Groundwater Modelling and management

SEMESTER 3

Sl no	Course code	Subject	Hours/Week			ICA	ESE	Total	Credits
			L	T	P				
1	CEH10 301	Elective IV	3	1	0	100	100	200	4
2	CEH10 302	ElectiveV	3	1	0	100	100	200	4
3	CEH10 303(P)	Industrial Training	0	0		0	50	50	1
4	CEH10 304(P)	Master Research Project Phase-I	0	0	22	300		300	6
	TOTAL		6	2	22	500	250	750	15

NB: The student has to undertake the departmental work assigned by HOD

ELECTIVE IV

CEH10 301A	Research Methodology
CEH10 301B	Advanced Finite Element Analysis
CEH10 301C	Numerical Methods
CEH10 301D	Spatial Modelling of Urban Systems

ELECTIVE V

CEH10 302A	Computational Fluid Dynamics
CEH10 302B	Soft Computing
CEH10 302C	Spatial Analysis in Watershed Management
CEH10 302D	Artificial Neural Networks

SEMESTER 4

Sl no	Course code	Subject	Hours/ Week			Internal Evaluation		ESE		Total marks	Credits
			L	T	P	Guide	EC	EE	VV		
1	CEH10 401(P)	Master Research Project Phase-II	0	0	30	150	150	150	150	600	12

EC-Evaluation committee; EE-External examiner; VV-viva voce

* The student has to undertake the departmental work assigned by HOD

SEMESTER 1

CEH10 101: APPLIED STATISTICS

(Common for CEE10 101/CEH 10 101)

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: ***To enable the students apply statistics in various areas of environmental engineering like sampling and analysis, stochastic modeling etc.***

MODULE 1

Probability Distributions: Probability mass functions and probability density function, mean and variance. Binomial, Poisson, Exponential, Gamma, Lognormal and normal distribution: Fitting of the distributions.

MODULE 2

Sampling techniques: Simple random sampling, stratified sampling, systematic sampling, sample size determination- application in Environmental Engineering

Regression and correlation: Linear Regression and correlation, multiple correlation coefficient, standard error of estimate, curvilinear regression- Applications.

MODULE 3

Statistical inference: Intervals estimation, Confidence interval for mean, variances and regression coefficients. Sampling Distribution, Test of significance of (i) Means (ii) Mean of two samples (iii) Proportions (iv) Variance (v) Two variances (vi) Two observed correlation coefficients (Fishers' z-transformation), (vii) Paired T-test (viii) Regression coefficients (ix) Chi-square test of goodness of fit, Skewness and Kurtosis tests.

MODULE 4

Applications: Analysis of variance (i) Completely randomized designs (ii) Randomized block designs. Latin squares. Grecco Latin square design. Factorial experiments. Graphical presentation techniques.

Time Series Models: Components of time series-smoothing- Measuring forecasting accuracy-Testing of ARIMA Models.

References:

1. Gupta.S.C. and Kapoor.V.K, Fudamentals of Mathematical Statistics, Sultan Chand and Sons, 1978.

2. Benjamin, Jack.R and Comell.C, Allin, Probability, Statistics and Decision for Civil Engineers, Mc-Graw Hill.

3. Kadiyali.L.R, Traffic Engineering and Transport Planning, Khanna Publishers.

4. Wohl, Martin and Martin, Brian.V, Traffic Systems analysis for Engineers and Planners, Mc-Graw Hill.

5. Richard.A. Johnson: Miller and Freunds, Probability and Statistics for Engineers (6^{th} edition)Pearson.

6. Elhance: fundamentals of Statistics.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 102 ADVANCED SURVEYING AND REMOTE SENSING

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective : ***To make the students understand the basics of new trends in the field of surveying and remote sensing.***

MODULE 1 (14hr)

Advanced surveying: Modern Surveying Equipment- digital levels-Electronic distance measuring Instruments(EDMI)-principle and components. Electronic theodolite- Total station-general typical characteristics.(2hr.)

GPS surveying:History-NAVSTAR system-advantages and current limitations of GPS. GPS principle. GPS receivers – type of receivers-consideration on selecting GPS receiver. Principle of position fixing with GPS- coordinate system for GPS.(4hr)

Photogrammetry : Geometric characteristics of aerial photographs – Photographic Scale – Photo coordinates and ground coordinates– Relief displacement- Stereoscopy- Image Parallax- Ground Control-Flight planning- orthophotos – Introduction to Digital Photogrammetry (6hr)

Hydrographic surveying: River surveys-soundings- method of sounding-method of location of sounding- use of modern equipments- Bathymetric systems with echo sounder and GPS-in hydrographic surveys. (2hr)

MODULE 2 (13 hrs)

Coordinate Systems and Geo-referencing – Concepts of coordinate systems – Concepts of map projections – classification of map projections, selecting a suitable map projection.

Introduction to remote sensing –Electro- magnetic spectrum – Physics of remote sensing – Effects of atmosphere – Atmospheric windows – Interaction of earth surface features with EMR – Spectral characteristics of vegetation, water, soil. Components of remote sensing - Characteristics of an ideal and real remote sensing system.

Sensors- –along the track Scanners and across the track scanners -Satellite system parameters- sensor parameters-spatial, spectral and radiometric resolution– Multi spectral sensors. Thermal and microwave imaging system- Earth Resources Satellite and Meteorological satellites. Indian remote sensing system.

MODULE 3

Different types of data products and their characteristics- formats-sources of errors-Data product output medium-digital products-IRS data products

Image Interpretation - Basic principles of visual interpretation – Elements of image interpretation - Equipment for visual interpretation – Activities of image interpretation – Ground truth.

Basic principles of digital image processing -Image restoration: Radiometric and geometric corrections, georeferencing, image statistics, histograms and scatter plots.

MODULE 4

Image enhancement– Radiometric: Contrast enhancement and density slicing; spatial filtering, texture and edge enhancement; Multispectral: ratio images (indices). Principal component analysis and IHS transformation: Frequency transformation (Fourier transforms)

Image Classification –Supervised: minimum distance to mean, parallelepiped, maximum likelihood and training. - unsupervised: single pass and iterative –Hybrid classification-classification of mixed pixels-post classification smoothing. Classification accuracy assessment.

Applications of Remote Sensing – Land use and lad cover mapping – Geologic and soil mapping – Terrain classification and evaluation – Water Pollution detection- Flood mapping-snow mapping- Urban and regional planning

References:

1. T.M. Lillesand and R.W.Kiefer, *Remote Sensing and Image Interpretation*, John Wiley and Sons, 1979

2. Anji Reddy, M. Remote Sensing and Geographical Information System, BSP Publications., 2001.

3. F.F Sabins(Jr.), *Remote Sensing : Principals and Interpretation*, Freeman & Co., San Francisco, 1978

4. George Joseph, *Fundamentals of Remote Sensing*, University Press, 2005.

5. R.N. Colwel (Ed.), *Manual of Remote Sensing*, Vol. I & II, American Society of Photogrammetry and Remote Sensing, Falls Church, Va. (1983)

6. Keith P.B., Thompson et. Al. (Ed.), *Remote Sensing and Water Resources Management*, American Water Resources Association, Urbana Illinois, 1973.

7. NRSA, E-book on remote sensing applications, published by NRSA 2010.

8. Hoffman-Wellenhof B., *GPS theory and Practice*, Springer Wien, New York, 1997

9. Sickle J.V., *GPS for Land Surveyors*, Ann Arbor Press, Chelsea, 1996

10. Kavanagh, B.F., 2003, *Surveying principles and applications* , Prentice Hall: New Jersy.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH 10 103 WATER RESOURCES SYSTEM ENGINEERING

Credits: 4

Hours per week: lecture – 3 and Tutorial – 1

Objective: To develop systems thinking as it relates to water resources planning management and to provide deterministic systems approach for analysis.

MODULE I

Water Resource Systems-concepts - definition, description of system components and characteristics of systems. Functions of water resource system. System analysis. Basic problems in system analysis. Steps in system approach. Techniques of Water Resources System analysis. Multi objective Planning. Need for systems approach to water resources.

MODULE II

Economic considerations in water resources system, general principles- discount factors – amortization – comparison of alternative plans. Equivalence in kind, equivalence in time. Cash flow diagram. Economic analysis. Benefit cost study—present worth analysis.

Mathematical Modeling of Water Resources: Problem formulation: decision variables, objective function. Constraints, parameters. water resources system modeling. formulation and selection. Modeling methods. Simulation versus optimization. -project selection decision making.

MODULE III

Introduction to operations research - linear programming- assumptions, problem formulation, graphical solution, solution by simplex method – Variations from standard form, the dual problem, Dual simplex method. Sensitivity analysis, - applications

Non-linear programming- one dimensional minimization methods – Newton – Raphson method, interval halving method, Fibonacci method.

MODULE IV

Dynamic Programming (DP): Introduction, solution of DP problems, characteristics of a DP problem, principle of optimality, application to civil engineering problems.

Simulation – Basic principles and concepts. Components of a simulation model, steps in simulation, combination of simulation and optimization.

References:

1. S Vedula & P P Mujumdar ***Water Resources Systems,*** Tata McGraw-Hill Publishing Company Ltd.
2. A Ravindran, Don T Philips & James J Solberg, ***Operations Research – principles and Practice.*** John Wiley & Sons.

2. Daniel P. Loucks, Jerry R. Stedinger & D.A Haith-***Water Resources systems Planning and Management.*** UNESCO Publishing.

3. Hall.W.A & Dracup.J.A- ***Water Resources Systems Engineering***

4. Mays L.W., and Tung YK, ***Hydro systems Engineering and Management.*** McGraw Hill Inc., New York, 19925.

5. Singiresu S Rao, ***Engineering Optimization Theory and Practice.*** New Age International (P) Ltd., Publishers, New Delhi.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 104 ADVANCED FREE SURFACE FLOW

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To instil in depth knowledge to the students so that it paves way for the integration of numerical modelling with GIS at a later stage

MODULE 1

Classification of free surface flow –Velocity and pressure distribution in open channel-effect of slope and curvature- Energy and momentum equation-Channel transitions- uniform flow and critical flow computation- Theoretical concepts related to uniform flow-boundary layer and its computation-velocity distribution in turbulent flow- method of determining manning's n for natural channel-both theoretical and practical.

MODULE 2

Dynamic equation - Classification and analysis of flow profiles - Computation methods - -Prismatic- Graphical/numerical integration- direct integration-direct step method, standard step method- method for non prismatic channels. Flow in the channel of non-linear alignment

Flow over Spillways - Hydraulic jump - Conditions and control of jump - Jump on sloping floor - Analysis - Applications.

MODULE 3

Spatially varied steady flow-principles and assumptions-Dynamic equation for spatially varied flow - Methods to compute flow profiles - Applications.

Gradually varied unsteady flow in open channels- Classification of water waves- Celerity, attenuation and amplification of waves- continuity and momentum equation for one dimensional flow –classification of routing models-kinematic, diffusion and dynamic waves. Modification of these equations for -Two dimensions, non-prismatic channels, flood plain storage- Assumptions and approximations in the derivation. –problems involving unsteady flow in open channels- general accurate and approximate methods of solution. Other methods of solving unsteady flow problems.

MODULE 4

Hydraulic flood routing through a stream-Numerical solutions-MOC –significance of characteristics-iterative procedure of solution- Incorporation of boundary conditions.

FDM in fixed grid -explicit and implicit methods, McCormack scheme- CFC-stability criteria- Incorporation of boundary conditions. Preissmann Implicit scheme- double –sweep solution.

Overland flows- Equations of spatially varied unsteady (2D) flow over a plane –Kinematic wave solutions for simple watershed geometry.

Reference

1. Chow V. T., Open channel Hydraulics, Mc Graw Hill book co., Inc., 1996
2. Henderson F. M., Open channel flow, Mc Millan Publishing Co., New York., 1986
3. Richard H. H., French, Open channel Hydraulics, Mc Millan Publishing Co., New York., 1985
4. Mahmood and Yejevich, Unsteady flow in open channels Vol.I&II, Water Resources Publication, Colorado, 1975
5. Subramaniya K., Open channel Flow, Tata Mc Graw Hill Publishing Co., 1997
6. Chow , V.T., D.R. Maidment and L.W. Mays, *Applied Hydrology*, McGraw Hill Book company, Singapore, 1988.

Internal continuous assessment: 100 marks

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End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 105: ELECTIVE I

CEH10 105A WATERSHED CONSERVATION AND MANAGEMENT

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: ***To provide a comprehensive treatise on the engineering practices of watershed management for realizing the higher benefits of watershed management.***

MODULE 1

Water shed: Introduction – Significance – Geology – Soil – Morphological Characteristics – Elements – Land Capability Classification –Delineation – Codification – Factors Influencing Watershed Development.

Fundamental concepts of geomorphology, Geomorphic agents and processes; Weathering and soil processes;

MODULE 2

Soil Conservation Practice: Types of Erosion – Wind Erosion: Causes, Factors, Effects and Control – Water Erosion: Types, Factors, Effects – Engineering Measures for Erosion Control in Agricultural and Non-Agricultural Lands – Estimation of Soil Loss

Water Harvesting Techniques – Design of Small Water Harvesting Structures – Types of Storage Structures – Yield from a Catchment – Losses of Stored Water

MODULE 3

Watershed Management: Strategies – Identification of Problems – Watershed Development Plan – Entry Point Activities — Concept of Priority Watersheds – Agro forestry – Grassland Management – Wasteland Management – Watershed Approach in Government Programmes –Developing Collaborative know how – People's Participation – Evaluation of Watershed Management

MODULE 4

Watershed Assessment Models: Regulation and Restoration – A Brief Description and Significance of Watershed Models: SWAT, TMDL, AGNPS, BASINS, CREAMS – Case Studies

References:

1. Debarry A. Paul, Watersheds, Wiley and Sons, 2004.
2. Devanport E. Thomas, Watershed Project Management Guide, Lewis Publishers, London, 2003.
3. Ghanashyam Das, Hydrology and Soil Conservation engineering, Prentice Hall of India Private Limited, New Delhi, 2000.
4. Glenn O. Schwab, Soil and Water Conservation Engineering, John Wiley and Sons, 1981.
5. Gurmail Singh, A Manual on Soil and Water Conservation, ICAR Publication, New Delhi, 1982.
6. Suresh, R. Soil and Water Conservation Engineering, Standard Publication, New Delhi, 1982.
7. Thornbury, W.D. *Principles of Geomorphology*, Wiley, 1968.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 105B INFORMATION TECHNOLOGY FOR GIS DATA MANAGEMENT

(Common for CEH10 105B/PMS10 105B)

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

OBJECTIVES

To study the data base management systems and basic internet technologies for the effective introduction of Geographic Information Systems.

MODULE I

Database Management Systems: Data - Information - Types - Database Models -Data encoding -Hardware and Software requirements -Database Management Systems - Types of DBMS - Hierarchial, Network, Relational Models - E-R diagram - Modern DBMS - Distributed Databases - Client Server Databases -Knowledge Based Systems - Geographic Databases -GIS.

MODULE II

File Organisation and Normalisation: File Organisation -Sequential, Indexed Sequential, Random, Multikey file Organisation - advantages and disadvantages - Relational Database Management System - Relational Algebra - Normalisation - case study for normalization using a Geographic data.

MODULE III

Fundamentals of computer networks: Computer networks- network layers- data communication concepts- Land topology and transmission media – network security –OSI reference model.

Network Security - Principles of Cryptography, Authentication, Integrity, Key Distribution and Certification

Access Control: Firewalls, Attacks and Countermeasures - Security in Many Layers: Case Studies.

MODULE IV

Web Technologies: Principles of Application Layer Protocols - The Web and HTTP, File Transfer: FTP, Electronic Mail in the Internet, DNS-The Internet's Directory Service - Static Web page: Types and Issues, tiers, comparisons open source and proprietary technologies.

HTML- different tags, sections, image & pictures, listings, tables, frame, frameset, form. Dynamic WebPages: The need of dynamic web pages; an overview of DHTML, cascading style sheet (css), comparative studies of different technologies of dynamic page creation. Active Web Pages.

References

1. Elmasri & Navathe, *Fundamentals of Database Systems*, Pearson Education, fourth
2. Keiser, G.E., Local area networks, Tata McGrawhill
3. C. J. Date, An Introduction to Database Systems, Addison Wesley, sixth edition, 1995
4. Kurose J.F. & Ross K.W, *Computer Networking: A Top -Down Approach Featuring the*
5. *Internet*, Pearson Education
6. Kenneth C. Laudon, Carol Guercio Traver, *E-Commerce-Business, Technology, Society*,
7. Pearson Education.
8. Bipin C. Desai, An Introduction to Database Systems, Galgotia Publications PVT LTD First edit 1993
9. Ramakrishnan R. & Gehrke J., *Database Management Systems*, McGraw Hill
10. O'neil P. & O'neil E., *Database Principles, Programming, and Performance*, Harcourt Asia,Morgan Kaufman
11. Silberschatz A., Korth H.F., & Sudarshan S., *Database System Concepts*, Tata McGraw Hill Ullman J.D., *Principles of Database Systems*, Galgotia Publications
12. Nalin K. Sharda, *Multimedia Information Networking*, Prentice Hall of India.
13. Douglas E. Comer, *Computer Networks and Internets with Internet Applications*, PearsonEducation
14. Stallings, *Computer Networking with Internet Protocols*, Pearson Education Asia.

15. Goncalves M., *Firewalls: A Complete Guide*, Tata McGraw Hill.
16. Kalakota R. & Whinston A.B., *Frontiers of Electronic Commerce*, Addison Wesley.
17. Schneider G.P. & Perry J.T., *Electronic Commerce, Course Technology*, McGraw Hill, NewDelhi, 2003.

Internal continuous assessment: 100 marks

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End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 105C: OPTIMIZATION TECHNIQUES

(Common for CEH10 105C /EPS10 105C /EPE10 105C)

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

***Objective*: *To apply the different optimization techniques to both linear and non-linear systems*.**

MODULE 1(13Hours)

Linear programming: Statement and classification of optimization problems overview of optimization techniques standard form of linear programming problems-Definitions and theorems-Simplex method-Revised simplex method-Duality and Dual simplex method-Sensitivity analysis.

MODULE 2(14Hours)

Unconstrained dimensional optimization techniques: Necessary and sufficient conditions-search methods(unrestricted Fibonacci and golden)-Interpolation methods(Quadratic, Cubic and direct root method).Direct search methods-Random search-pattern search and Rosen Brock's hill climbing method-Descent methods-Steepest descent, conjugate gradient,Quasi Newton and DFE method.

MODULE 3(14Hours)

Constrained optimization techniques & dynamic programming:

Necessary and sufficient conditions-Equality and inequality constraints-Kuhn-Tacker conditions-Gradient projection method-cutting plane method-Penalty function method(Interior and exterior).Principle of optimality-recurrence relation-Computation procedure-continuous dynamic programming.

MODULE 4(13Hours)

Recent developments in optimization techniques:

Rosenbrocks Rotating Coordinate Method-Tabu search-Simulated Annealing-Genetic Algorithm-Particle Swarm Optimization –Ant colony Optimization-Bees Algorithm.

References:

1. Rao S.S,'Optimisation:Theory and Application',Wiley Eastern Press,1978
2. Pierre, D.A. 'Optimisation Theory with Applications' John Wiley & Sons, 1969
3. Fox, R.L., 'Optimisation method for Engineering Design', Addition Welsey,1971.
4. Hadely,G., 'Linear Programming', Addition Wesley, 1962.
5. Bazaara &Shetty, 'Non-linear Programming'.
6. D.E. Goldberg, Genetic Algorithm in Search, Optimization, and Machine Learning. Reading, MA: Addison-Wesly, 1989.
7. Marco Dorigo, Vittorio Miniezza and Alberto Colorni "Ant System:Optimization by a colony of Cooperation Agents" IEEE transaction on system man and Cybernetics-Part B:cybernetics, Volume 26, No 1, pp. 29-41,1996.
8. Shi, Y. Eberhart, R.C., "A Modified Particle Swarm Optimizer", Proceedings of the IEEE International conference on Evolutionary Computation, Anchorage, AK, pp. 69-73, May 1998
9. Recent literature should also be referred

Internal continuous assessment: 100 marks

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End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 105D: PHYSIOCHEMICAL PROCESSES FOR WATER AND WASTEWATER TREATMENT

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: ***To make the students understand the principles of physico-chemical processes for the treatment of water and wastewater.***

MODULE1

Process dynamics-Reactions and Reactors- Mechanics of mass transport-reactions and energetics-kinetics and reaction rates-reactor engg. and process design.Screenings-types of screens-head loss in screens. Equalization process-types of equalization process-volume of equalization basins

MODULE 2

Sedimentation-sedimentation processes- types of settlings- tube settlers-design of sedimentation tanks. Coagulation and flocculation- coagulation processes-stability of colloids-destabilisation of colloids in water and wastewater treatment-transport of colloidal particles.Floatation and aerosol separation-methods of floatation-gas particle contact-dissolved air floatation. Filtration-filtration processes-filter media- types of filters-mechanisms of filtration-hydraulics of filtration-filter problems -effluent quality-design of filters

MODULE 3

Disinfection-processes-methods of disinfection-factors influencing-nonchemical methods-details of chlorination-other disinfectants. Adsorption-adsorption process-adsorption isotherm-adsorption kinetics-factors influencing-design of adsorption units. Ion exchange-process-materials-exchange reactions-application in water and wastewater treatment-design of units.Membrane process-Reverse osmosis-electrodialysis-ultra filtration-membrane properties-process design.Chemical oxidation-principles and theories-generation and application of chemical methods

MODULE 4

Sludge treatment-characteristics of sludge-dewatering methods-conversion process-anaerobic and aerobic digestion-combustion-disposal, of sludge.

References

1. Weber W. J. Physico-chemical processes for water quality control (Wiley Inter-science,1972)
2. Rich L. G. Unit operations of sanity engineers (Wiley Topan)
3. Fair G. M Etal- Water and wastewater engg
4. Stermm,W & Morgan J. J.-Aquatic chemistry
5. Halfferic F.- Ion Exchange

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 106(P): SEMINAR

Credits:2

Hours per week 2

Objective: To assess the debating capability of the student to present a technical topic. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage that are essential for engineers.

Individual students are required to choose a topic of their interest from water resources and hydroinformatics related topics preferably from outside the M.Tech syllabi and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in water resources and hydroinformatics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

CEH10 107(P): ADVANCED SURVEY &HYDROLOGY LAB

Credits: 2

Hours per week: 2

Objective ***To analyse the characteristics of water/wastewater samples***

Advanced surveying Lab

Total station survey

Study measurement of angle by repetition and setting the horizontal angle to value

Basic level measurement-distance, REM and MLM and area

Resection

3D coordinate measurement-recording data

Transferring data- contouring

Setting out

Hydrologic Engineering lab

Infiltrometer-Fitting of Hortan's model and other models

Hydrologic set up- Verification of water balance equation.

Pumping test in open well.

Determination of velocity distribution in an open channel flow, energy and momentum coefficients in open channels, construction of isovels

Hydrographic survey- study of bathymetric system

Internal continuous assessment: 100 marks

SEMESTER 2

CEH10 201 GIS AND HYDROINFORMATICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To provide a comprehensive treatise on the Geographic Information System and Hydroinformatics so that the student is equipped for the spatial analysis of hydrologic information

MODULE 1

Geographic Information System – History and development of GIS – GIS definitions and Terminology -Architecture– System concepts – Coordinate systems – Standard GIS packages

Type of data – Spatial and non- spatial data – Data structure – Points – Lines – Polygon – Vector and raster – Files and data formats – Spatial data modeling –Raster GIS model and Vector GIS models.-GIS data file management and Database models

MODULE 2

Data input-Existing GIS data –meta data-conversion of existing data-Creating new data

Geometric transformation-control points-RMS error. Application of geometric transformation

Spatial data editing –location errors-topological errors- topological editing –nontopological editing—other editing operations.

Attribute data input and management- Attribute data in GIS-Relational model-Attribute data entry-manipulation of fields and attribute data.

MODULE 3

Data display and cartography- symbolization- map design

Data exploration- attribute data querry-spatial data querry-raster data querry- Graphic visualisation

Vector data analysis- Buffering-ovelay-distance measurement-pattern analysis

Raster data analysis-Local operations – Neighbourhood operations-zonal operations-Other raster data operations-

MODULE 4

Terrain mapping and analysis-Teraain mapping- TIN contouring –slope and aspect-surface curvature –Raster vs TIN

Viewshed and watersheds- Viewshed analysis- application for view shed analysis- Watershed analysis Filled DEM –Flow direction- Flow accumulation-stream network and stream link. Factors influencing watershed analysis- applications

Introduction to spatial analysis-global and local methods-kriging

Application of GIS to various fields of Engineering.

References:

1. Chang, K (2005). Introduction to Geographic Information Systems, *Tata Mc Graw Hills Edition, NewDelhi*
2. Burrough and McDonnel, *Principles of Geographical Information System*, Oxford University Press, 1998
3. Praveen kumar, Jay Alameda, Peter Bajcsy; Hydroinformatics, Taylor & Francis, 2006
4. Maidment D. R., Arc Hydro, GIS for Water resources, ESRI Press, 2002
5. Han J. , M. Camber; Data Mining: Concepts and techniques, Morgan Kaufmann, San Francisco, 2001
6. Meijentric etal, *Introduction to the use of GIS for practical Hydrology,* Publication No.23, The International Institute of Aerospace Survey and Earth Sciences(ITC), The Netherlands, 1994
7. Bruce E Davis, *GIS: A Visual Approach* , Onword Press, Canada 2001
8. *Geographic Information Systems: A Management Perception*. WDL Publications, Ottawa, 1989
9. *M Anji Reddy, Remote Sensing and Geographic Information Systems,* B S Publications, Hyderabad, 2001
10. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992.
11. Burrough P.A., Principles of GIS for Land Resources Assessment, Oxford Publication, 1980.
12. Jeffrey Star and John Estes, Geographical Information System – An Introduction, Prentice – Hall Inc., 1990.

13. Marble D.F., Galkhs H.W. and Pequest, Basic Readings in Geographic Information System, Sped System Ltd., New York, 1984.
14. Clarke, K.C. Parks B.O., and Crane M.P. (2006) Geographic Information systems and environmental modeling- PHI of India , New Delhi.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 202 ADVANCED HYDROLOGY AND WATER RESOURCES ENGINEERING

(Common for CEE205A/CEH10 202)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To make the knowledge base of the student in Hydrology stronger and broader so that they can handle the design and analysis of the environmental systems with confidence.

MODULE 1

Fundamental hydrology-Hydrological cycle-components of hydrologic cycle –

Rainfall- atmospheric circulation –types and forms of precipitation-Rainfall data and its processing- frequency analysis-probability distribution and its application hydrology.-IDF Curves and DAD curves and its derivation and uses.

Water losses-Infiltration-Hortans' and Green Ampt model runoff-Indices.

Hydrograph-components- base flow separation- unit hydrograph- S and synthetic hydrograph.

MODULE 2

Ground water flow and well hydraulics-Aquifer parameters-land subsidence due to over pumping- steady radial flow in to a well-well in uniform flow-steady flow with uniform charge-and steady flow in to a well confined, unconfined and leaky aquifers-well near aquifer boundaries-multiple well systems-partially penetrating wells –-pumping tests. Non equilibrium for pumping test-Theis method.-Jacob's method-Chow's method.

Salt water intrusion, ground water basin development, and Artificial recharge.

MODULE 3

Open wells – Design of open well –yield test.- Methods of construction-dug wells.

Tube wells –design-screened wells-gravel packed wells- -selection of screen size-yield of a well

Well loss- determination of well loss by step pumping method.

Test holes-well logs - shallow tube wells -deep wells - -drilling in rocks-screen installation-well completion- well development-testing wells for yield-failure of tube wells.

Collector of radial wells. cavity wells and Infiltration galleries

MODULE 4

Yield estimation: flow duration curve and mass curve –reservoir capacity and design. Hydrologic equation and water balance studies- flood routing studies.

Floods-estimation: Empirical -Rational formula- hydrograph method- flood frequency analysis- Gumbel's and Log-pearson type III.

Regression – Linear and non-linear - correlation- Methods of assessing error in hydrologic data and hydrologic computation.

Modelling – Classification of models based various criteria – Physically based models – Classification of PDEs- Methods for solution – FDM –Explicit and Implicit equation -solution procedure for Laplace and Unsteady ground water flow equation- and FEM (Basic concepts only)

References:

1. Singh, V.P. *Elementary Hydrology.* Prentice Hall of India, New Delhi, 1994.
2. Chow , V.T., D.R. Maidment and L.W. Mays, *Applied Hydrology*, McGraw Hill Book company, Singapore, 1988.
3. McCuen, R. H. *Hydrologic analysis and design*, Prentice Hall, Eaglewood Cliffs, New Jersey, 1989.
4. Subramanya, K. Engineering Hydrology, Tata Mcgraw Hill, Newdelhi,1994
5. Raghunath H.M..-Hydrology H.M Wiley Eastern Ltd Newdelhi,1985
6. Raghunath H.M..- Groundwater , New Age International, 2007
7. Ciriani T.A -Mathematical models for surface water hydrology
8. Tood D. K.-Ground water hydrology, Wiley Eastern
9. Viessman,L and Knapp.-Introduction to hydrology
10. Duggal and Soni, Elements of Water Resources Engineering, New Age International, 1996
11. Garg S.P, Ground water and tube wells, Oxford &IBH Newdelhi, 1982.

12. Chapra, S.C and Canale, R .P. Numerical methods for Engineers, Mcgraw hill Int.1990.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 203: ENVIRONMENTAL IMPACT ASSESSMENT

(Common for CEE10 203/CEH10 203)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To make the students aware about the ecological and social costs of unrestrained technological progress and the importance of protection of environment through environmental impact assessment.

MODULE 1

Concept of environmental impact analysis –Legislations, laws and Acts relevant to Environmental protection in India – Factors for consideration in assessing environmental impacts- Measurement of environmental impacts – Short term and long term effects.

Socioeconomic impact analysis- Types of socioeconomic impacts – Outline of the basic steps in performing socioeconomic impact assessment.

MODULE 2

Air quality impact analysis - Air pollutants-sources - Atmospheric interaction- Environmental impact assessment methodology

Noise impact analysis- typical considerations- Environmental impacts and effects of noise on people- control of noise pollution.

MODULE 3

Water quality impact analysis – water quality criteria and standards –Environmental setting-modelling - water quality impacts by projects like highways, power plants, mining, agriculture and irrigation, forest management.

Energy impact analysis- Energy impact considerations, organization and methodology.

MODULE 4

Vegetation and wildlife impact analysis – Environment assessment – assessment methodologies

Summarization of Environmental Impact –Checklist method, Matrix method, Network method.

References:-

1. John G. Rau and David C. Wooten –Environmental Impact Analysis Handbook.

2. Canter –Environmental Impact Assessment.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 204: ELECTIVE II

CEH10 204 A: WATER POLLUTION CONTROL AND STREAM SANITATION

(Common for CEE10 204A/CEH10 204A)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To make the students aware about the sources of surface water pollution, their control and stream quality standards

MODULE 1

Introduction-importance of water sources-socio-economic importance-sources of pollution-types of waste-waste products of man's activities-sources of stream pollution-types of waste products-location and management of waste loads-projecting waste loadings

Water quality and stream quality standards

MODULE 2

Eutrophication-organic pollution-oil pollution-radioactive pollution-marine pollution-thermal pollution-pesticide pollution-heavy metal pollution

Organic self purification-quantitative definition-reoxygenation-oxygen balance and stream dissolved oxygen profile-oxygen sag curve-Streeter Phelp's equation-Critical deficit-problems

Microbial self purification-pathogenic microorganisms of sewage origin-indices of contamination-enumeration-percapita contribution-seasonal variations-death rate survival in the stream environment

MODULE 3

Classification of streams-natural self purification process-disposal of wastewater-

Rational stream sanitation practices-dual objectives of stream sanitation practices-the science and art of applied stream sanitation-stream survey-types of stream survey-execution of stream surveys

Purification in estuaries-evaluation of self purification in estuaries-tides and currents-distribution of waste loads by tidal translation-sea water intrusion-waste assimilation capacity of estuaries-bacterial contamination-stable wastes

MODULE 4

Impacts of river developments on waste assimilation capacity-detrimental and beneficial effects-hydroelectric power-navigation works-flood control works-irrigation and other diversions

References:-

1. Phelps E. Stream Sanitation
2. Viez Applied stream sanitation
3. P. K. Goel Water pollution, causes, effects and control
4. Todd G. K. Applied Groundwater hydrology

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH 10 204 B: MANAGEMENT INFORMATION SYSTEM

(Common to MIT10 204B/ PMS10 204B/CEH10 204B)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objectives:- To provide knowledge on different types of Information systems and their applications in industry.

MODULE 1 (13 Hrs.)

The Concept of MIS - Role of MIS - Characteristic of MIS - Functional Subsystems - Activities Subsystems Pre-requisites of MIS-Contemporary Approaches to MIS-Technical Approach, Behavioural Approach,-Socio-technical Approach, Technical Approach-Information as Strategic Resource-Use of Information for Complete Advantage.

MODULE 2 (14 Hrs.)

Evolution of Computers-Computer Hardware-Generation of Computers-Complete Categories - Software - System Software, Application Software-Data Communication - Data Processing-Transaction Processing-Data Processing Modes-Data Transmission-Functions of Telecommunication- Communication-Transmission Channel- Characteristic of Communication Channel- Network - Topologies, Types of Networks, OSI, TCP/IP-Internet -Internal, External, ISDN - Multimedia-IT Enabled Services - SPO, Call Centers, MT, GIS-Information.

MODULE 3 (14 Hrs.)

Management-Decision Making - Decision Types, Decision Making Process,-Decision Making Tools, Principle of Rationality, Principle of Logic & Interaction-Decision Making Models - Classical Model, Administrative-Model, Herbert, Simon Model-Information - Sources of Information, Types of Information, Information requirements, Techniques for Assessing-Information Requirements - Systems Analysis and Design-System- Types, Characteristics-Control- Control Process, Requirements of Good Control-System, Control System-Law of Requisite Variety-Systems Development-System Analysis, System Design, System Implementation, System Development Process-System Development Life Cycle-Rapid System Development Tools - Prototyping, CASE Tools, Object Oriented Systems 4

Decision Support System-The Decision Support System - Components, Characteristics, Structure -Group Decision Support System-Configuration, Features-Executive Information System / Executive Support System-Definition, Characteristic, Capabilities, Benefits-Expert System-Artificial intelligence Database Management System-DBMS Components-Database Model.

MODULE 4 (13 Hrs.)

Data Warehousing & Data Mining-Data Warehousing Definition, Structure / Architecture-Data Mining - Information Security and Control-Information System Security Threats-External & Internal Threats Information System and Quality-Quality Assurance-Software Quality Assurance-Management Role in Software Quality Assurance -Quality Assurance Methods - Quality Profile Model, Construction Quality Model, Tick IT, Initiative-Functional applications of MIS -Stores & Purchase Management-Accounts Payable System-Inventory Management-Production Management System -Marketing Service System-Applications in Service Sector-MIS Application in Service Industry-Airlines, Hospital, Banking.

References:

1) Jerome Kanter – Managing with Information
2) Gordon B. Davis and Alson – Management Information Systems
3) Robert C Murdick Joel E Ross and James R Clagget – Information Systems for Modern management
4) Henry c Lucas Jr. – The Analysis Design and Implementation of Management Information Systems.
5) Kickson and Wheterbe – Management Information Systems.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks	Question 3: 20 marks	Question 5: 20 marks	Question 7: 20 marks
Question 2: 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 marks

CEH10 204C FLUVIAL HYDRAULICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective : To make the student aware of the processes in river engineering

MODULE I

Introduction : River morphology- physical characteristics – channel configuration, meandering, bends,coursings, transitions**.**

River behavior: Channel geometry-equilibrium, agradation and degradation, effects of long contraction over bank flow bands and crossing meanders- super critical flow in rivers. Stream profiles and bed material, bank erosion – importance of bank erodability, braiding, bends.

MODULE II

Measurement of stream flow: Stage measurement, measurement of channel geometry measurement channel discharge- direct and indirect method, stage discharge relationship.

Sediment Engineering: Origin and formation of sediments, fundamental properties of individual sediment particle,bulk properties of sediments**.**

MODULE III

Incipient motion: Competent velocity, life concept, critical tractive force- empirical equations for critical tractive stress, Shield analysis, White's analysis**.**

Regimes of flow: Description of regimes of flow, origin and characteristics, importance.

Bed load transport: Du-Bouy equation, Einstein's equation, Kalinske's equations**.**

MODULE IV

Suspended load transport: Diffusion in turbulent flow, differential equation for suspension of sediment, Einstein's Approach, distribution of suspended sediment**.**

Sediment samplers: General remarks, bed load samplers-suspended load samplers classification.

Stabilization and rectification of rivers: Alignment, radius of curvature, control lines, River training works.

References

1. Margaret Peterson, River Engineering-
2. R.J.Garde, K.G.RangaRaj, Mechanics of sediment transportation and alluvial stream problems-
3. W.W.Graf, Hydraulics of Sediment transport-
4. Serge Leliavsky, An Introduction to Fluvial Hydraulics-

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 204D: BIOLOGICAL METHODS IN ENVIRONMENTAL ENGINEERING

(Common for CEE10 201/CEH 10 204D)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective*: *To familiarize the students with collection and characterization of wastewater samples, their treatment and disposal and advanced wastewater treatment process and their applications

MODULE 1

Objectives of biological treatment – Role of microorganisms in waste water treatment – Types of biological processes for waste water treatment – Different microbial metabolisms – Bacterial growth patterns – Microbiological treatment kinetics and flow regimes – Michaelis-Menten and Monod models – Rate of biomass growth with soluble substrates – Kinetic coefficients – Effect of temperature – Oxygen requirements – Biomass yield – Observed yield – Kinetic constants evaluation of biological treatment.

MODULE 2

Aerobic biological treatment – Attached growth and suspended growth treatment systems – Modeling suspended growth treatment process – Activated sludge process – Description – Various types – Methods of aeration – Microbiology – Process analysis – Process design considerations – Operational difficulties – Modifications.

Sequencing Batch Reactor – Process description and operation.

Trickling filter – Filter classifications – Microbiology – Process design considerations – Design of physical facilities – Recirculation – NRC Equation – Operational difficulties.

MODULE 3

Aerated lagoons – Types – Process design considerations.

Stabilisation ponds – Classification – Design considerations.

Sludge treatment and disposal – Characteristics of sludge – Sludge processing – Preliminary operations – Thickening – Stabilizatio - Aerobic digestion - Anaerobic digestion –

Composting – Conditioning – Dewatering - Heat drying - Incineration- Wet air oxidation – Land application

MODULE 4

Advanced biological treatment processes – Nitrogen removal – Nitrification and Denitrification -Stoichiometry – Process analysis – Operational and environmental variables.

Economics of biological treatment – Constructional cost, capital cost, operational cost – Total cost.

References

1. Metcalf and Eddy Inc. - Waste Water Engineering: Treatment, disposal and reuse,Tata McGraw Hill
2. Benefield and Randall- Biological treatment Process – Design for waste water treatment,

   Prentice Hall of India, New Delhi.
3. Hammer- Water and Waste Water Technology, John Wiley and Sons
4. Quano- Principles of Waste Water Treatment, Vol. I, Oxford and IBH
5. Eckenfelder and Conner – Biological waste Treatment

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 204E DATA ACQUISITION IN HYDROINFORMATICS

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective :To make the student aware of the various options of data acquisition system required for processing the data in Hydroinformatics

MODULE I

Use of automatic and digital levels, electronic theodolites, total stations, Data acquisition and transfer of data from machine to the field. Use of total station for collecting GIS compatible data-file formats- File transfer

MODULE 2

Satellite Navigational Systems. **Global Positioning Systems:** (NAVSTAR, GLONASS, GALILEO). Basic concept of GPS: pseudo range and carrier phase measurements, signal structure, GPS coordinate systems:

MODULE 3

GPS time; GPS Errors and biases; GPS orbital Geometry and Navigational solution;

Surveying with GPS; Planning and field observations; Data post-processing;

GIS and GPS integration;

MODULE 4

Map concepts, co-ordinates and Map projection

Control surveys using GPS, Total station and triangulation methods (adjustment and computations of coordinates); Cartography and report writing.

References:

1. Hoffman-Wellenhof B., *GPS theory and Practice*, Springer Wien, New York, 1997
2. Wells D.E., *Guide to GPS Positioning*, Canadian GPS Association, New Brunswick, Canada, 1988
3. Anderle R., *The Global Positioning System*, Royal Society of London, U.K.
4. Kennedy M., *The Global Positioning System and GIS: an Introduction*, Ann Arbor Press, Chelsea, 1996

5. Sickle J.V., *GPS for Land Surveyors*, Ann Arbor Press, Chelsea, 1996

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 205 ELECTIVE III

CEH10 205A ADVANCED HYDROLOGIC ANALYSIS AND DESIGN

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective:

To introduce the concepts of systems approach to hydrological modelling and design procedures used for safe and effective passage of flood flows

To discuss the Analysis of Hydrologic time series and stochastic hydrologic models.

MODULE 1

Hydrologic And Hydraulic Models: Hydrologic investigation - systems approach – concept of a model. Classification of hydrological models, Chow-Kulandaiswamy model. Time-area methods –Unit Hydrograph – Instantaneous Unit Hydrograph. – Synthetic Unit Hydrographs. Clark model, Nash model, Tank model.

MODULE 2

Hydrologic Simulation And Stream Flow Synthesis: Classification of Hydrologic Simulation Models. Single-Event Rainfall-Runoff Models. Continuous Simulation Models. Groundwater Flow Simulation Models. Streamflow Synthesis.

Risk Analysis – Design Storms and its synthesis. Design Flows. Urban Storm Drainage Design, Airport Drainage Design, Detention Storage Design.

MODULE 3

Random Processes: Classification – Stationary Random process - Components of time series – Trend Analysis – Regression – Multiple Linear Regression – Diagnostic tools.

MODULE 4

Forecasting Models: Box Jenkins' models – Correlation – Auto correlation – Partial auto correlation – Yule Walker equations – AR(p) – MA(q) – ARMA(p,q) – ARIMA (p,d,q) models – model formulation – Validation – Application.

References:

1. Singh, V. P. Hydrologic Systems, Prentice-Hall Englewood Cliffs, NJ 1989.
2. Jayarami Reddy P., Stochastic Hydrology Laxmi Publications, New Delhi 1995.
3. Viessman W Jr. Introduction to Hydrology (5ed) Pearson Education, Inc. 2003.
4. Haan C.T., Statistical Methods in Hydrology Iowa State Press 2002.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 205B GROUND WATER CONTAMINATION AND POLLUTION TRANSPORT

(Common for CEE10 205B/CEH10 205B)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To learn the principles of pollution transport, and estimation of extent of contamination by modelling

MODULE 1

Ground water and the hydrologic cycles-Ground water as a resource-Ground water contamination-Ground water as a geotechnical problem-Ground water and geologic processes. Physical properties and principles-Darcy's law-Hydraulic head and fluid potential-piezometers and nests. Hydraulic conductivity and permeability-homogenicity and anisotropy-porosity and voids ratio-Unsaturated flow and the water table-steady state flow and transient flow-compressibility and effective stress-transmissivity and storativity-Equations of ground water flow -Limitations of Darcian Approach-hydro dynamic dispersion.

MODULE 2

Resource evaluation: development of ground water resources-Exploration of Aquifers-the response of ideal aquifers to pumping-Measurement of parameters-Laboratory tests-Numerical simulation for aquifer yield prediction-Artificial recharge and induced infiltration-land subsidence - sea water intrusion

MODULE 3

Chemical properties and principles: constituents -chemical equilibrium-association and dissociation of dissolved species-effects of concentration gradients-mineral dissolution and solubility-Oxidation and reduction process-Ion exchange and adsorption-environmental isotopes-field measurement of index parameters. Chemical evolution: ground water in carbonate terrain-ground water in crystalline rocks-ground water in complex sedimentary systems -geotechnical interpretation of 14C dates-process rates and molecular diffusion.

MODULE 4

Solute transport: water quality standards-transport process-non reactive constituents in homogeneous media-transport in fracture media-hydrochemical behaviour of contaminants-trace metals-nitrogen-trace non metals-organic substances-measurement of parameters – velocity-dispersivity-chemical partitioning- sources of contamination-land disposal of solid waste-sewage disposal on land.

USGS-Moc model: modelling principles-MOC modelling.

References

Randall J. Charbeneau-Ground water Hydraulics and Pollutant Transport

Allen Freeze R. and John A. Cherry -Ground water. Prentice Hall.Inc

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 205C ENVIRONMENTAL GEOLOGY

(Common for CEE10 205C/CEH10 205 C)

Credits 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To learn the fundamentals of geology in environmental planning and analysis of systems

MODULE 1

Fundamental concepts of environmental geology-concepts of ecology-flood and impact on environment-Nydel projects and environment-depositional environments-resources and silting-lakes-lagoons and estuarine environments-coastal erosion and impact on beach environment-Aeolian deposits and their environmental consequences-wind erosion and related environmental problems

MODULE 2

Geology and urban planning-problems of urbanization. Environmental analysis in planning of rural and urban areas. Environmental consequences of natural calamities like volcanic activity, earth quakes and landslides. Disposal of waste from nuclear and thermal stations and factories. Impact of waste disposal in the quality of ground water. Vulnerability of ground water to pollutants. Ecologist's role in management of waste disposal.

MODULE 3

Natural resources utilization and the environment. Green house effect and global warming. Chlorofluorocarbons and holes in the ozone layer. Problems in mining environment. Environmental legislation in India. Marine pollution-marine base sources-oil spills-processes of oil water interface-effects of ecosystems.

MODULE 4

Definition and scope of medical geology-environmental and health. Heavy metal pollutants (Cd,Hg,Pb,Re,Ra,As).Problems relating health and geology. Man-environment relationship. Trace elements in human biology. Goiter and iodine, fluorosis, fluorite, multiple sclerosis and Pb, As poisoning, Cesium and heart disease, radiation hazards.

References:

1.Strahler A.N and Strahler A.H.-Environmental geosciences. Wiley International

2.Pacyna J.M. and Ohar B. -Control and fate of atmospheric trace metals.

3.Raiz Akhtar - Environment and health

4.Park J.E. and Park K.-Textbook of preventive and social medicine.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 205D WATER POWER ENGINEERING

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To learn various aspects and types of water power generation

MODULE I

Introduction: Sources of energy, types of power, choice of type of generation .Components of a water power project, types of hydropower schemes and their general layouts. Concept of Power transmission. Estimation of Hydropower available-Basic water power equation, estimation of discharge and head available. Preliminary choice of the type of system.

Nature of demand: Load curves, load duration curves, load factor. Plant capacity factor, plant use factor, firm and secondary power .Intakes: Types, elements of an intake, hydraulic design of various elements.

MODULE II

Conveyance System: Power channel, pressure conduits, tunnels. General concepts of design and the economics. Surge tank: Function, location, types such as simple, restricted orifice, differential, air cushion chamber type. Basic design criteria. Fore bay.

MODULE III

Power Station: Types , elements of a power station. General criterion for the design of main dimensions of the power house .Economic comparison of underground power stations with the surface power stations. Turbines: Classification, characteristics of different types, choice of type. Turbine setting and cavitations

Tail race: Functions, types (channel and tunnel).Draft tubes, function and principal types.

MODULE IV

Pumped storage plants: Concepts , general layout , types and economics. Tidal power stations: Concepts , general layout , classification , types. Other types of power plant:

(a)Depression power plant (b) Micro Power Station – Need for the development and the problems faced.

References:

1. Mosonyl, E.-"Water Power Development" Vol. I & II

2. Brown, G. Etal -"Hydro – electric engineering practice" Vol. I, II & III.

3. Dandekar M.M-"Water Power Engineering VIkas Pub. House Pvt. Ltd.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 205E GROUNDWATER MODELLING AND MANAGEMENT

Credits: 4

Hours per week: Lecture-3 and Tutorial-1

Objective: To introduce the students to the application of management models to estimate the groundwater quantity and qualities. After the completion of the course, the student should able to understand the inputs, system parameters, policy, variables and outputs of a groundwater management models.

MODULE 1

Investigation and evaluation – Geophysical methods- Electrical Resistivity methods – Interpretation of data – Seismic method – Subsurface investigation – Test drilling – Resistivity logging – Application of remote sensing techniques. Assessing yield - pumping tests-recuperation tests-yield of open well

Physical models – Analog models – Mathematical modeling – Unsaturated flow models

MODULE 2

Numerical modeling of groundwater flow – Finite Differential equations - Finite difference solution – Successive over Relaxation, Alternating direction implicit procedure – Crank Nicolson equation – Iterative methods -Direct methods - Inverse problem – Finite element method

Contaminant transport theory – Advection, dispersion equation – Longitudinal and transverse dispersivity – Hydrodynamic dispersion – Analytical models – Numerical simulation of solute transport – Solution methods - Sorption model – Subsurface mass transport through the vadose zone - Density driven flow - Heat transport.

MODULE 4

Data requirements – Conceptual model design : Conceptualization of aquifer system – Parameters, Input-output stresses, Initial and Boundary conditions - Model design and execution : Grid design, Setting boundaries, Time discretization and Transient simulation – Model calibration : steady state and unsteady state – sensitivity analysis – Model validation and prediction – Uncertainty in the model prediction

Introduction to software for groundwater modelling under open source and proprietary schemes

MODULE 4

Optimal groundwater development – Indian GEC norms – Conjunctive use models Modeling multilayer groundwater flow system -Modeling contaminant migration – Modeling fracture flow system – Artificial recharge feasibility through modeling – Simulation of movements of solutes in unsaturated zone – Stochastic modeling of groundwater flow - Groundwater contamination, restoration and management

References:

1. Anderson M.P., and Woessner W.W., Applied Groundwater Modelling : Simulation of flow and advective transport, Academic Press, Inc., 1992
2. Fetter C.W., Contaminant Hydrogeology, Prentice Hall, 1999
3. Rushton K.R., Groundwater Hydrology : Conceptual and Computational Models, Wiley, 2003
4. Elango L. and Jayakumar, R. Modelling in Hydrology, Allied Publishers Ltd., 2001
5. Remson I., Hornberger G.M. and Moltz F.J., Numerical Methods in Subsurface Hydrology, Wiley, New York, 1971
6. Robert Willis and William W.G.Yenth, Groundwater System Planning and Management, Prentice Hall, Englewood Cliffs, New Jersey, 1987.
7. Groundwater Hydraulics and Pollutant Transport, Randall J.Charbeneau, Printice Hall, 2000

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 206(P): SEMINAR

Credits:2

Hours per week 2

Objective: To assess the debating capability of the student to present a technical topic. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage that are essential for engineers.

Individual students are required to choose a topic of their interest from Water Resources And Hydroinformatics related topics preferably from outside the M.Tech syllabi and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Water Resources And Hydroinformatics) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

CEH10 207(P)|GIS LAB

Credits:2

Hours per week 2

Image processing functions.

Pre processing – merging and segmentation.

Geo referencing of Images

Image statistics and Histogram.

Enhancement techniques.

Supervised classification.

Unsupervised classification

GIS Functions

Data Import/Export

Digitization

DEM Generation

Spatial Analysis

Data Output

.**References:**

1 American Society of Photogrammetry, (1983). *Manual of Remote Sensing*, (2nd edition), ASP, Falls Church, Virginia

2. Lillisand.T.M, and Kiefer, P.W., (1998). *Remote Sensing And Image Interpretation*, John Wiley & Sons, New York.

3. Burrough and McDonnel, *Principles of Geographical Information System*, Oxford University Press, 1998

4. Robert A.Schowengerdt, Remote Sensing: *Materials and Methods for Image processing*, Academic Press: Elsevier, 2007

5.Chang, K (2005). Introduction to Geographic Information Systems, *Tata Mc Graw Hills Edition, NewDelhi*

SEMESTER 3

CEH10 301: ELECTIVE IV

CEH10 301A RESEARCH METHODOLOGY

(Common for CEH10 301A, CEE10 301A, MIT10 301C, EPS10 301A, EPE10 301A, PMS10 301A)

Credits:4

Hours per week: Lecture-3 and Tutorial-1

***Objective: To impart knowledge about various methodologies followed in engineering research, formulation of research problems and to apply the same in project work. To make students aware of the problems faced by Indian researchers*.**

MODULE 1

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research. Research process – Criteria for good research – Problems encountered by Indian researchers.

MODULE 2

Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions – Field Study – Critical Analysis of Generated Facts – Hypothetical proposals for future development and testing, selection of Research task

MODULE 3

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

MODULE 4

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

References:

1. J.W. Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York

2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.

3. C. R. Kothari, Research Methodology, New Age Publishers.

4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH 10 301B: ADVANCED FINITE ELEMENT METHODS

(Common for CEH10 301 B/MIT10 301A/MPE10 301A)

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objectives

- *To master linear finite element procedures and programming techniques.*
- *To understand the basic mathematics of finite element analysis and equip the students to formulate finite element procedures for engineering problems.*
- *To train the students in structural, thermal and flow analysis problems using finite element software.*
- *To introduce finite element procedures and programming techniques for non-linear and transient problems.*

Pre-requisites

- *A basic knowledge of Partial differential equations, Structural Mechanics, Heat transfer, Fluid Mechanics and Elementary Finite Element Method.*

Module I (14 hours)

Introduction – review of computational procedures with 1D elements – interpolation and shape functions – 2D elements – simple solid elements – element matrices for structural mechanics, heat transfer and fluid flow problems – choice of interpolation functions - convergence and completeness conditions – modelling considerations – symmetry - applications.

Module II (14 hours)

Isoparametric formulation – 1D and 2D elements – numerical integration – choice in numerical integration – patch test. Coordinate transformation – transformation of characteristic matrix – transformation of restraint directions. Imposition of constraints – Lagrange multiplier and penalty function methods. Error – sources of error – ill conditioning – convergence – error estimates.

Module III (13 hours)

Boundary value problems – weak and strong forms – functionals – Euler-Lagrange equations – Rayleigh-Ritz method – finite element formulation from a functional. Weighted-residual methods – Gelerkin, least-square and collocation methods – Gelerkin finite element formulation – applications to structural, thermal and fluid flow problems.

Module IV (13 hours)

Finite element formulation for non-linear problems – solution methods - Newton-Raphson method – modified Newton-Raphson method – convergence criteria – applications. Transient finite element procedures – FE equations and matrices - integration techniques – applications. Introduction to coupled analyses (fluid-structure interaction, thermo-mechanical problems) and contact problems.

References:

1. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis,* John Wiley & Sons
2. D. V. Hutton, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill
3. S. S. Rao, *The Finite Element Method in Engineering*, Butterworth Heinemann
4. J. N. Reddy, *An Introduction to the Finite Element Method,* McGraw Hill International Edition
5. K. J. Bathe, *Finite Element Procedures in Engineering Analysis,* Prentice Hall of India
6. O. C. Zienkiewics, R. L. Taylor, *The Finite Element Method,* Vol I & II, McGraw Hill
7. H. C. Huang, A. S. Usmani, *Finite Analysis for heat transfer*, Springler-Verlag, London.
8. D. R. J. Owen, Earnest Hinton, *Finite Elements in Plasticity, Theory & Practice*, Pineridge Press
9. G. W. Rowe, C. E. N. Sturgess, P. Hartley, I. Pillinger, *Finite Element Plasticity and Metal Forming Analysis*, Cambridge University Press, UK
10. Ted Belytschko, Wing Kam Liu, Brain Moran, *Non-linear Finite Elements for Continua and Structures*, John Wiley & Sons Ltd.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

CEH10 301C NUMERICAL METHODS

(Common for CEE10 301C/CEH 10 301C)

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objective: To use mathematical knowledge in solving problems like optimization, correlation of data etc. and for modelling

MODULE 1

Solution of algebraic and transcendental equations- Review and comparison of various iterative methods, convergence- Generalized Newton- Raphson method for multiple roots-

Higher order methods- Newton's method for non-linear systems.

MODULE 2

Solution of simultaneous equations-Direct & indirect methods-Gauss elimination and Gauss Jordan methods- ill conditioning- pivoting – Jacobi, Gauss-Seidel and relaxation methods-convergence-Eigen value problems-Vector iteration method

Interpolation- Newton's Divided difference, Lagrange, Aitken, Hermite and Spline techniques – Inverse interpolation –Error estimates-Double interpolation-Trigonometric interpolation.

MODULE 3

Numerical differential-Numerical integration-Newton–Cote's integration formula-Gauss quadrature –Error estimates-Double integration.

Curve fitting-method of least squares – nn-linear relationships – Correlation and Regression – Linear Correlation – Measure of correlation – Standard error of estimate – Coefficient of correlation – Multiple linear regression.

MODULE 4

Solution of ordinary differential equations-Single step & multi step methods-stability of solution – simultaneous first order differential equations - higher order different equations. Numerical solution of integral equations.

Partial differential equations – classification – Laplace equation, ID wave equation, ID heat equation – Finite difference method – Relaxation methods. Stability and convergence of solution.

References:

1. Jain M.K., *Numerical methods for Scientific and Engineering Computation*
2. Conte and Carl DeBoor, *Elementary Numerical Analysis*
3. Gupta A and Bose S C, *Introduction to Numerical Analysis*
4. Hilderbrand FB, *Introduction to Numerical Analysis*
5. Fjorberg C E, *Introduction to Numerical Analysis*
6. Kendall E Atkinson, *An Introduction to Numerical Analysis*
7. Murrey R Spiegel, *Statistics*
8. James B. Scarborough, *Numerical Mathematical Analysis*
9. C F Gerald & P O Wheatley, *Applied Numerical Analysis*
10. E V Krishnamurthy & S K Sen , *Numerical algorithms*

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 301 D SPATIAL MODELLING OF URBAN SYSTEMS

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objective: To equip the students for the effective planning and design of urban systems by using spatial modelling

MODULE 1

Urbanization, Spatial behavior, Urban Spatial modelling, Urban Systems, and Management approaches, Rural and urban impacts of urbanizations.

Built environment – Land use planning – Density control, housing, slums, and squatter settlements – Infrastructures- water supply, soil and liquid waste, transportation and other services – Need for Enviornmental Management in Cities and Towns, Urbanization.

MODULE 2

Urban Design – scope, frame work, goals and principles – design process- gathering information- identifying hard and soft areas for various functions – functional analysis – Spatial design theories : Figure ground theory, Linkage theory – Design Paradigms

MODULE 3

Spatial modeling of urban System Dynamics – Application of Computational Models - Spatial topological structure of urban land cover information

MODULE 4

Application of GIS in the Management of Natural Enviornment in urban areas.

Fractal geometry and its applications to Urban patterns, settlement patterns – GID and fractal formulation

References

1. Tony Kendle and Stephen Forbes, "Urban Conservation – Landscape Management in Urban country Side – E & FN SPON, London, 1997.

2. The Royal Commission on Environmental Pollution Report – Transport and Environment-Oxford University Press, 1995.

3. Rob Gray – Accounting for the Environment – Chartered Association of Certified Accountants – 1003.

4. Brain I.L. Berny – Urban Environmental Management

5. Richard Kelly, Stuart Barr, Spatial modeling of Terrestrial Environment, John Wiley, 2004

6. Barnsley M. J., Donnay J. P., Remote Sensing and Urban Analysis, Taylor and Erancis,2000

7. Stewart F.Michael W., Spatial Models and GIS: New Potential and New Models, Taylor and Francis, 1999

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 302 A COMPUTATIONAL FLUID DYNAMICS

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objective: To understand the application of numerical methodologies for solving the problems in compressible and incompressible flow problems

MODULE 1

System and control volume approaches – velocity, acceleration, Reynold's transport theorem – conservation of mass, momentum and energy equations – Gradient of velocity – deformation and rotation tensors – stress strain relations – Navier – Stoke's equations – Cartesian and polar coordinates(derivation) – Energy equation – Boundary layer equation.

MODULE 2

Stream function – potential flow –various combinations of simple type potential flows– vorticity stream function formulation – potential flow – Turbulence and turbulence modelling.

Finite difference schemes – backward - central and forward schemes – stability analysis

MODULE 3

Finite volume method for incompressible flows – Vertex centered and cell centered FVM – Treatment of convection term – Upwind, hybrid, upwind least square reconstruction and QUICK schemes – staggered and collocated grids – solution algorithms for both types – Evaluation of velocity field – SIMPLE, SIMPLER, and projection methods – Time dependent problems – Implicit, Crank-Nicolson and Explicit schemes

MODULE 4

Finite volume method for compressible flows-Treatment of convection terms – Flux vector splitting method – Artificial diffusion – Structured and unstructured grids – Solution of system of equations – Tridiagonal matrix algorithm – Line by line solver.

Development of a computer program for the analysis of incompressible flows in two dimensions – solution of few typical problems using the computer program. Study of any two latest papers describing development in CFD.

References:

1. J D Anderson : *Computational Fluid Dynamics* – Mc Graw Hill International, 1995
2. C A J Fletcher : *Computational Techniques for Fluid Dynamics* – Vol 1 & 2, Springer Verlag, 1988
3. S V Patankar : *Numerical Heat Transfer* – Hemisphere, 1980
4. K Muralidhar and T Sundrarajan : *Computational Fluid Flow and Heat Transfer*, Narosa Publishers, 1996.
5. K.Muralidhar and G.Biswas: *Advanced Engineering Fluid Mechanics*, Narosa Publishers, 1996.
6. Joel H Ferziger, Milovan Peric : *Computational Methods for Fluid Dynamics.*
7. http://www.fluidyn.com

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH 10 302B SOFT COMPUTING TECHNIQUES

(Common for CEH10 302B/EPE10 302B /EPS10 302B /PMS10 302B)

Hours/week: Lecture-3 and Tutorial-1

Credits: 4

Objective: To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic, genetic algorithms and hybrid algorithms and enable the students to implement real time intelligent and adaptive systems.

MODULE 1 (13Hours)

Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller(Block Diagram)

MODULE 2 (14Hours)

Artificial Neural Networks: Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self organizing maps-ART

MODULE 3 (13Hours)

Fundamentals of genetic algorithms: Basic concepts- working principle – encoding – different methods – fitness function – reproduction-different methods. Genetic modelling-inheritance- Crossover mutation-convergence of genetic algorithm.

MODULE 4 (14Hours)

Hybrid systems: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back

propogation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.

REFERENCES

1. S.Rajasekharan, G.A.Vijayalakshmi Pai, *Neural Network, Fuzzy Logic and GeneticAlgorithms Synthesis and Applications*, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India.
3. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill ,New York.
4. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.
5. D.E.Goldberg, *Genetic Algorithms in Search Optimisation and Machine Learning*, Pearson Education.
6. Recent Literature.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination: 100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 302C SPATIAL ANALYSIS IN WATERSHED MANAGEMENT

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objective: To introduce advanced GIS technologies for watershed management

Pre-requisite: CEH10 201

MODULE 1

Spatial Analysis **:** Understanding spatial analysis - operators and functions –local, focal, zonal, global and application functions – surface analysis: slope, hill shade, contour and hydrologic analysis – mapping distance: shortest path – mapping density – cell statistics – neighborhood statistics – reclassification.

MODULE 2

Creating Surface models: creating raster surface from points – interpolating a raster surface – creating TIN surface from vector data – building TIN – creating a TIN from a raster – creating a raster from a TIN.

Analyzing Surfaces: Understanding the shape of a surface – calculating slope, mapping contours - deriving contour lines from a surf ace – calculating area and volume.

MODULE 3

Application of GIS in water resources -Hydro networks- Flow direction-Flow Accumulation-river addressing-Drainage systems-watersheds-Drainage analysis using DEM-Watershed Delineation-Watershed Analysis-Flood plain delineation-River modelling-Digital Terrain Models-Time series

MODULE 4

Integrating GIS with Hydrologic Modelling- Basic elements of GIS modelling -Classification of GIS modelling- modelling process- Integration of GIS with hydrologic modelling -binary models-index models- Regression models-process models- Building of raster and vector based binary and index models

References:

1. Burrough, P.A.. *Principles of Geographical Information Systems for Land Resource Assessment*. Oxford University Press Inc., New York., 1986
2. David R Maidment, , *Arc Hydro GIS for Water Resources*, ESRI Press, Redlands, California., 2002
3. Heywood, Cornellius and Carver, *An Introduction to Geographical Information Systems*, Pearsen Education (Singapore) Pvt. Ltd., Delhi – 110 092, 2001
3. Mitchell, A., , *The ESRI Guide to GIS Analysis Volume 1: Geographical Patterns and Relationships*, Environmental Syste ms Research Institute, California.
4. Mitchell, A., Booth Bob and Crosier Scott, 2002, *Getting Started with Arc GIS*. Environmental Systems Research Institute, Inc., Red Lands, California.
5. Mitchell, A., Booth Bob and Crosier Scott, 2002, *Arc GIS Spatial Analyst* Environmental Systems Research Institute, Inc., Red Lands, California.
6. Tsung Chang – Kang, 2002, *Introduction to Geographic Information Systems*, Tata McGraw -Hill Publishing Comp any Limited, New Delhi.
8. Ven Te Chow, *Handbook of Applied Hydrology*, McGraw-Hill, New York, 1964.
9. Keith P.B., Thompson et. al. , *Remote Sensing and Water Resources Management*, American Water Resources Association, Urbana Illinois, 1973.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	Module 2	Module 3	Module 4
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 302D ARTIFICIAL NEURAL NETWORKS

Credits:4

Hours per week: Lecture-3 and Tutorial-1

Objective: To give a comprehensive treatise on the various neural network models and their respective field of applications

MODULE I

Introduction to Neural Networks Biological Neurons and Neural Networks, Networks of Artificial Neurons. Single Layer Perceptrons, Learning and Generalization in Single Layer Perceptrons, Hebbian Learning, Gradient Descent Learning, learning rates, Widrow-Hoff Learning , The Generalized Delta Rule, Practical Considerations

MODULE 2

Basic neural network models ADALINE networks, LMS algorithm, Learning in Multi-Layer Perceptrons, Back-Propagation algorithms, Radial Basis Function Networks: Fundamentals, Algorithms and Applications, Learning with Momentum, Conjugate Gradient Learning, Bias and Variance. Under-Fitting and Over-Fitting. Applications of Multi-layer Perceptrons.

MODULE 3

Basic learning models Associative Learning, Competitive Networks, Winner-take-all networks, Adaptive Resonance Theory (ART), Neural networks as associative memories, Hopfield network, BAM, Self Organizing Maps: Fundamentals, Algorithms and Applications. Learning Vector Quantization, Optimization problems solving using neural networks, Stochastic neural networks, Boltzmann machine

MODULE 4

Applications of artificial neural networks: Application areas like system identification and control, decision making, pattern recognition, pattern mapping and sequence recognition.

References

1. Simon Haykin, *"Neural Networks",* second edition, Prentice Hall, 1999
2. Christopher M. Bishop, *Neural Networks for Pattern Recognition* by Oxford University Press, 1995
3. Rumelhart, D.E., and J.L. McClelland (eds.) *Parallel distributed processing: explorations in micro structure of cognition*., Vol. I, Cambridge, MA: MIT Press, 1986.
4. Martin T. Hagan, Howard B. Demuth, Mark Beale*, Neural Network Design,* Vikas Thomson learning

5. Freeman, J.A. and D.M. Skapura, N*eural networks: algorithms, applications and programming techniques.* Addison Wesley Publishing Company, New York, 1991.
6. Yegnanarayana, B. (1994) Artificial neural networks for pattern recognition. *Sadhana*, 19(2), 189-238

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suit best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Two questions of 20 marks each from each module and Answer any 5 questions by choosing at least one question from each module.

Module 1	**Module 2**	**Module 3**	**Module 4**
Question 1 : 20 marks	Question 3 : 20 marks	Question 5 : 20 marks	Question 7 : 20 marks
Question 2 : 20 marks	Question 4 : 20 marks	Question 6 : 20 marks	Question 8 : 20 marks

CEH10 303(P): INDUSTRIAL TRAINING

Credits: 1

Hours per week -30 (during the period of training)

The students have to arrange and undergo an industrial training of minimum two weeks in an industry during the semester break after semester 2 and complete within 15 calendar days from the start of semester 3.The students are requested to submit a report of the training undergone and present the contents of the report before the evaluation committee. Evaluation committee will award the marks of end semester examination based on training quality, contents of the report and presentation.

End semester examination : Marks 50

CEH10 304(P): MASTER RESEARCH PROJECT PHASE 1

Credits: 6

Hours per week: 22

Objective: To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work can be a design project/experimental project and or computer simulation project on any of the topics in WATER REOURCES AND HYDROINFORMATICS or related topics. The project work is allotted individually on different topics. As far as possible the students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work.

The student is required to undertake the masters research project phase 1 during the third semester and the same is continued in the 4th semester (Phase 2). Phase 1 consist of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

Internal Continuous Assessment:

	Guide	**Evaluation committee**
First review	**50**	**50**
Second review	**100**	**100**

Total: 300 marks

SEMESTER 4

CEH10 401(P): MASTERS RESEARCH PROJECT PHASE 2

Credits: 12

Hours per week: 30

Objective: To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Master Research project phase 2 is a continuation of project phase 1 started in the third semester. Towards the end of the semester there would be a pre submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conference. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external.

Internal Continuous assessment:

	Guide	**Evaluation committee**
First review	**50**	**50**
Second review	**100**	**100**

End Semester Examination:

Project Evaluation by external examiner: 150 marks

Viva Voce by external / internal examiner: 150 marks(75 each)

Total:600 marks